Power and The Engineer

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THE engineer or fireman who has fallen into the habit of finding fault with everything about his plant is about as disagreeable a companion as can be found.

Some men make themselves so obnoxious by continual fault finding that it is a relief to their fellow workmen when their watch is over.

This fault is generally the outcome of some fancied or real grievance, generally fancied. The injured feelings of the man finally develop into chronic "grouch," and when this stage of mental disorder has been reached nothing short of a severe lesson will bring relief, and often the lesson will produce no results.

Some men work under conditions that are well-nigh unbearable, but even in such cases many of the disagreeable features could be removed if they were given proper attention.

It does not take a visitor long to detect the chronic "kicker," as he begins to portray the disadvantages of this and that, magnifying the smallest faults and many times ignoring those of greater magnitude.

A case in point is as follows: A certain boiler room has a very smooth concrete floor which, when damp, is quite slippery; otherwise the boiler room is ideal, being large, light and well ventilated.

The only real "kick" to which the fireman is justly entitled is on account of the slippery concrete floor, which would probably prove more satisfactory had its surface been corrugated.

But instead of working out some means for overcoming this condition, such as nailing a piece of old rubber to the heels of his working shoes, the fireman when talking with a stranger, gives the impression that the boiler room is hardly a fit place to work in.

"Kicking" over trivial matters that can be easily remedied is little short of childish. Most men would find a way of quietly overcoming such difficulties.

It is poor policy to criticize to a stranger, or a friend for that matter, the plant in which you are working, because you are telling a disinterested party something that is, in a way, a family affair and should be so considered.

The stranger may be a director of the company; he may be a good engineer who will see that the fault is not altogether in the plant. Or the hearer may be a manufacturer "sizing you up" to determine whether you are a fit person to put in charge of his steam plant.

If an engine is worn out don't forever "kick" about it, but get it in decent running condition. Many an engineer has made a name for himself by doing this very thing.

To be "grouchy" or to complain continually does not pay. Friends are not gained in this way, and enemies multiply. If it is impossible to say a good word about the chief, the plant, or the firm you are working for, say nothing.

Mum is the word.

Metropolitan Home Office Plant

By F. L. Johnson

The power plant of the tallest office building in the world is equipped to give the widest range of service. Besides the regular features of heat, light and ventilation, there are refrigeration, cold storage, filtered air and water, and a host of minor conveniences demanded by the present-day tenant. A feature is the unique system of keeping records of the various departments.

If an engineer should be asked to design a power plant for a modern office building which was to stand on a piece of ground the value of which could be closely approximated by covering it with fifty-dollar gold certificates, it is highly probable that an efficient and reliable installation would be sought. It was a problem very much like this that was solved when the power plant for the home-office building of the Metropolitan Life Insurance Company was designed. In an office building there are so many kinds of service to be considered that each must be treated in its relation to all of the others. At the outset is the power problem. This includes everything requiring the expenditure of energy, and when the requirements are as carefully approximated as is possible, the relation of this feature to the heating must be considered. The power must be furnished for the entire year, while heat is needed for only a portion, and if the steam machinery selected will furnish exhaust steam sufficient for heating during the coldest weather, it will be extravagant in the amount of steam used per horsepower-hour. The problem to be solved is to correlate the heating requirements with the motive-power machinery so that the total fuel used for both heating and power purposes shall be the least quantity possible.

In the equipment of this building it was intended that for several months of the year the exhaust-steam supply for heating should be supplemented by steam from the boilers through automatic pressure-reducing valves. This arrangement, while apparently increasing the amount of live steam taken from the boilers in the cold season, made it possible to generate the power needed in the summer months by economical units, so that a measurable degree of economy is secured.

The main building occupies an entire city block, 425x200 feet, which, with its eleven stories and the 75x85-foot tower at one corner reaching a hight of 700 feet above the sidewalk, contains upward of 25 acres of floor space.

Steam is furnished by eleven Babcock & Wilcox boilers in the subbasement, having a total capacity rating of 3500 horsepower. They are arranged on either side of broad alleys, and are served with con-

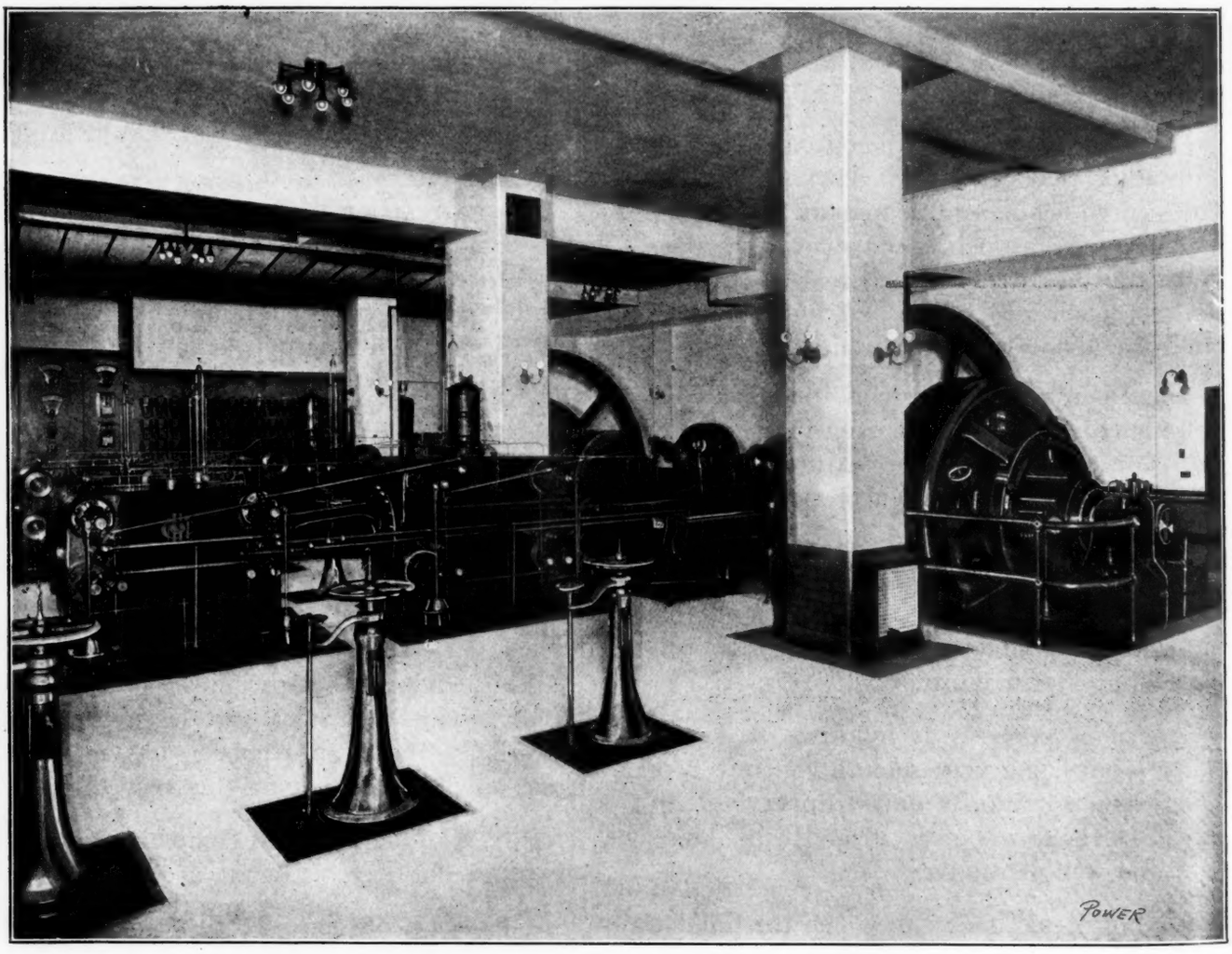

FIG. 1. VIEW OF ENGINE ROOM FROM VISITORS' GALLERY

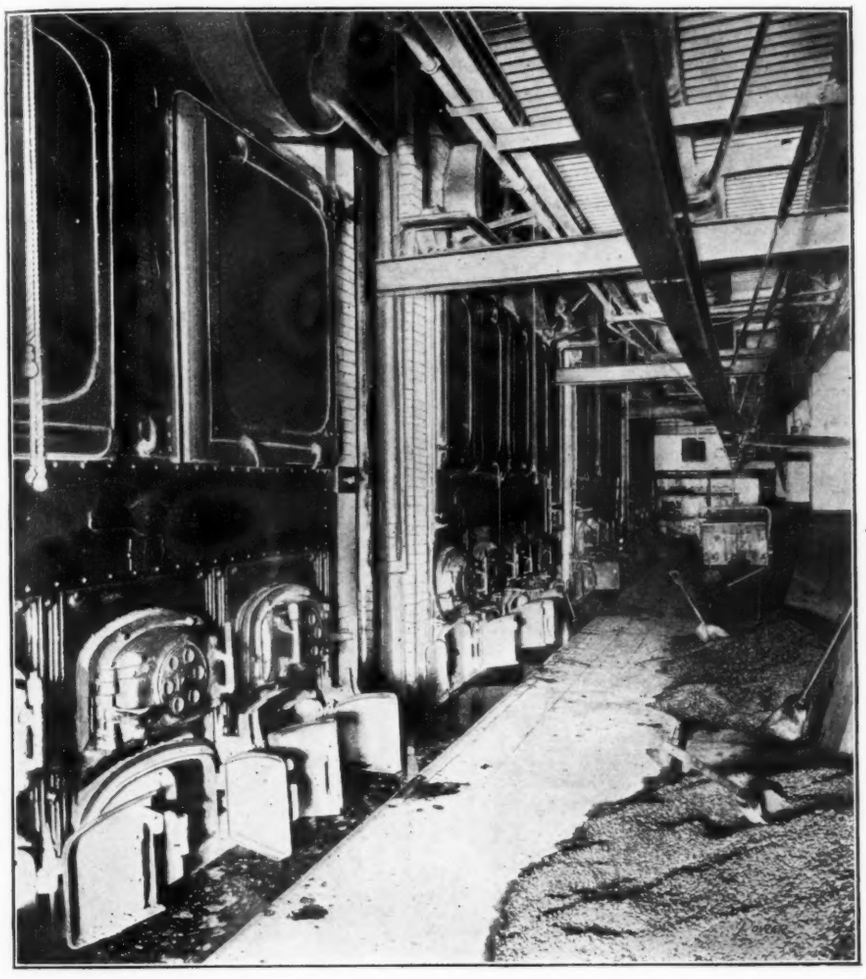

FIG. 2. A VIEW IN THE BOILER ROOM

veniently arranged tracks, both on the floor and overhead, for the handling of coal and ashes. The coal and ash tracks lead to the bunkers of 4000 tons capacity under the sidewalks and to the ash elevators. Each boiler is independently connected to a steam gage on the gage board in the engine room, which shows plainly to the engineer on the floor above at all times the number and location of every boiler under pressure. There are also on the gage board a Bristol recording steam gage and a recording thermometer connected to the uptake leading to the chimney.

The boilers are equipped with superheaters furnishing steam through the comparatively long pipe under the engine-room floor with 50 to 60 degrees of superheat at the engines.

In the engine room there are five compound noncondensing engines, each having a direct-current generator mounted on the shaft. One is an Allis-Chalmers cross-compound of 650 kilowatts capacity; the other four are Rice & Sargent tandem compounds—two of 200, one of 300 and one of 400 kilowatts capacity. There are in the same room three three-cylinder compound noncondensing Laidlaw-Dunn-Gordon high-pressure elevator pumps, each having a capacity of 720 gallons per minute against a pressure of 800 pounds per square inch. There is also a compound duplex Worthington direct-acting elevator pump of 300 gallons capacity per minute against the same pressure, and a pilot-valve pump which furnishes the water for the operation of the elevator pilot valves at a pressure much below the 800 pounds per square inch operating on the elevator plungers. The high-pressure pumps deliver the water directly to the pressure tanks which are connected to six weighted accumulators located in an alcove adjoining the engine room.

One interesting feature of the plant is the mammoth report chart in the chief engineer's office. It is a graphic record of each day's work taken from the reports and put on the chart, which shows the relation of every factor in the plant to every other one. It consists of a "board," about 12 feet long and 4 feet high, on which the different kinds of service are represented by colored twine passing over and held in place by tacks driven into the "board" at the proper points. In the illustration near the top of the board *B* is the temperature base line from which the exhaust and live-steam lines *A* and *C*, respectively, are plotted. All of the lines above *B* represent exhaust steam and the line *C*, which is below *B*, the live steam used to supplement the exhaust when needed. The line *D* is the outdoor temperature curve and shows how closely the heating requirements follow this temperature. The line *E* shows the number of kilowatts generated, each point in the line representing the output for a single day. The consumption of city water for all purposes is represented by the line *F*, and its relation to the other lines on the board may be easily traced, particularly in the case of the line *G*, which records the amount of fuel used.

From the Twenty-third street postal substation, which is in the Metropolitan building, to the general post office downtown, the mail is transmitted in pneumatic

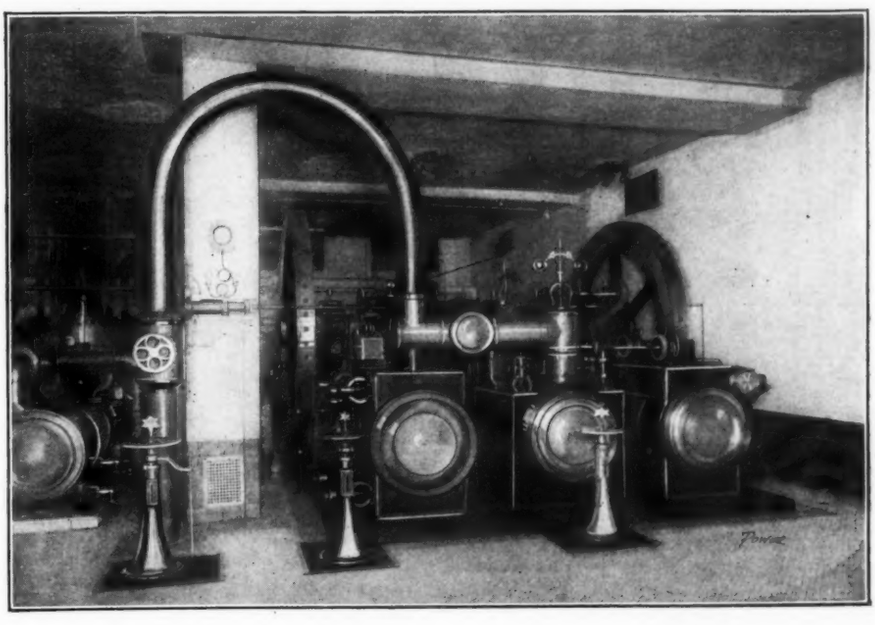

FIG. 3. ONE OF THE COMPOUND ELEVATOR PUMPS

tubes. The air is furnished by the plant and the power used from day to day is recorded by the line *H*.

Elevator service, which means a summary of the number of cars in service and a totality of trips, is shown by line *I;* and the labor line, which is more regular in its irregularity than any of the others, is designated by the letter *J*. Re-

door-temperature line is calculated from different base lines which are not shown. The highest and lowest points reached each week give a clear idea of the range over which each service operates.

There are many little "kinks," so called, in different parts of the plant which are of more than passing interest to the observer. One is a ball-bearing swivel car. The device is the invention of Charles Bavier, chief engineer of the plant. It was, however, found to be unpatentable because years before an artillery officer had used the same device to allow a chain to rotate without kinking. Its earlier application has one compensating feature, the engineer can use his own device without having to pay a

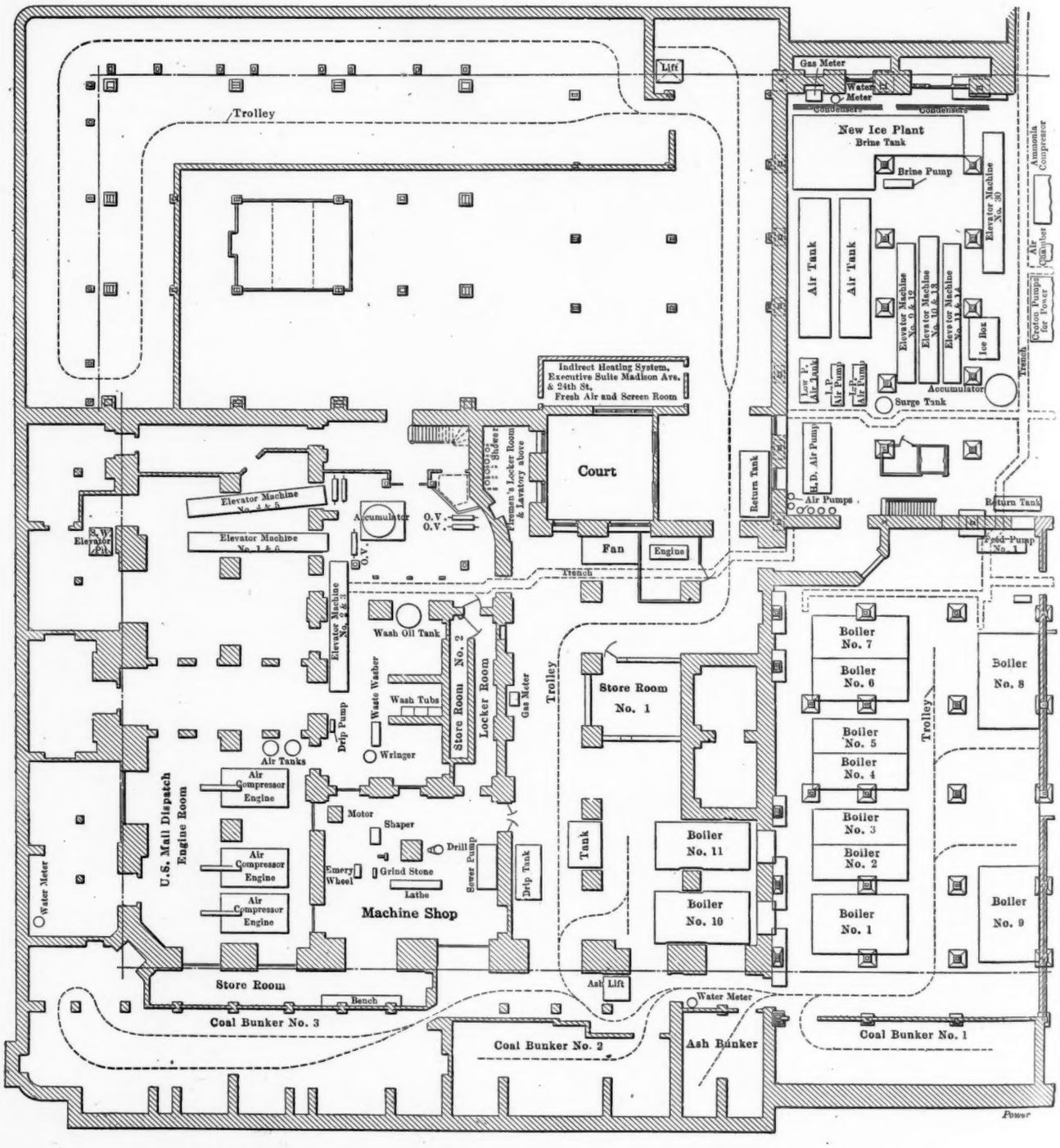

FIG. 4A. SUB-BASEMENT PLAN SHOWING LOCATION OF FOUNDATIONS AND MACHINERY

frigeration is marked by the line *K*, while the comparative hights of the electrical peak loads for each day are recorded by the base line *L*.

Each of the eight lines below the outcable connection on the end of the elevator cables, which prevents any tendency to strain from the twisting and untwisting of the cable that takes place at every change of tension during every trip of the royalty to some patent-owning shark, as many another has.

In the laundry there is an efficient washing machine constructed along original lines. It consists of a sheet-copper

box about 5 feet long and 1 foot square with tapering ends. It is supported on trunnions at the middle of its length and when in use is slowly revolved by a small electric motor. Whatever is to be washed is put inside with soap, or washing powder, as may be desired, and cold water. The cover is put on and the motor started. At the end of an hour or a day, or any other period, the box is opened and the contents removed. As the box revolves end over end, the contents drop from one end to the other, the pyramid-shaped ends acting to give a gentle squeeze at the end of each drop and to turn over the garment, or whatever is inside, at each change of direction. As a washing machine, the kink is perfect. The smooth sides, tapered ends and slow motion drive the water through the fabric in a different direction at every turn and cause practically no wear.

Near this machine are the drier and the steam-heated ironing table and pressing roll.

To the sightseer the tower clock is an interesting feature. Located some 350 feet above the street it is visible over a great part of the city. Some of the details are quoted.

"The dials are built up of reinforced concrete faced with vitreous blue and white mosaic tile. Each dial is 26 feet 6 inches in diameter. The figures on the dial are 4 feet high and the minute marks 10½ inches in diameter.

"The minute hand measures 17 feet from end to end, 12 feet from center to point, and weighs 1000 pounds; the hour hand measures 13 feet 4 inches from end to end, 8 feet 4 inches from center to point and weighs 700 pounds. They are built on iron frames, sheathed with copper, and revolve on roller bearings.

"The driving power of this huge mechanism is electricity; none of the many devices connected therewith require any manual operation, the entire installation being automatic.

"The master clock, located in the di-

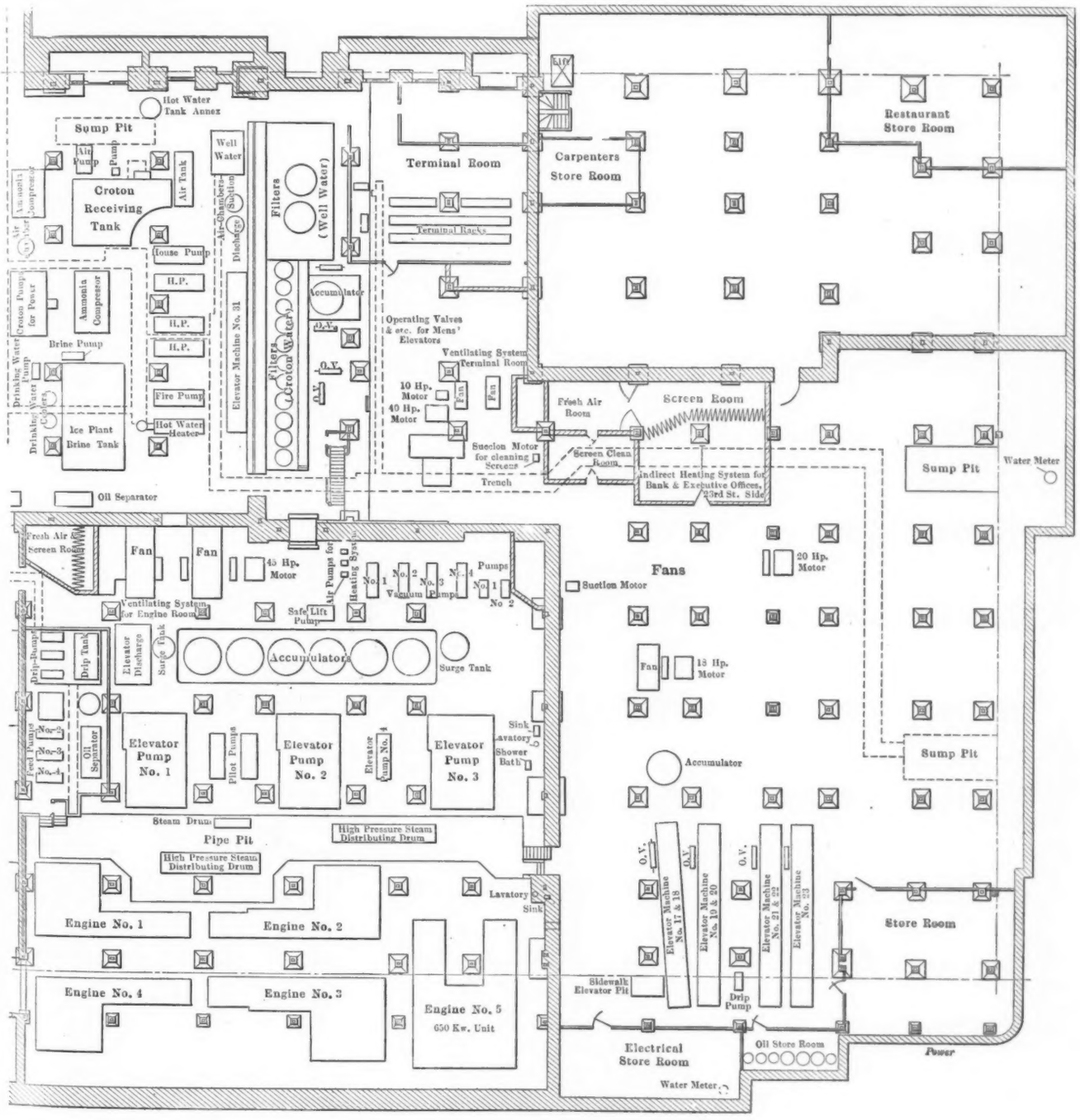

FIG. 4B. SUB-BASEMENT PLAN SHOWING LOCATION OF FOUNDATIONS AND MACHINERY

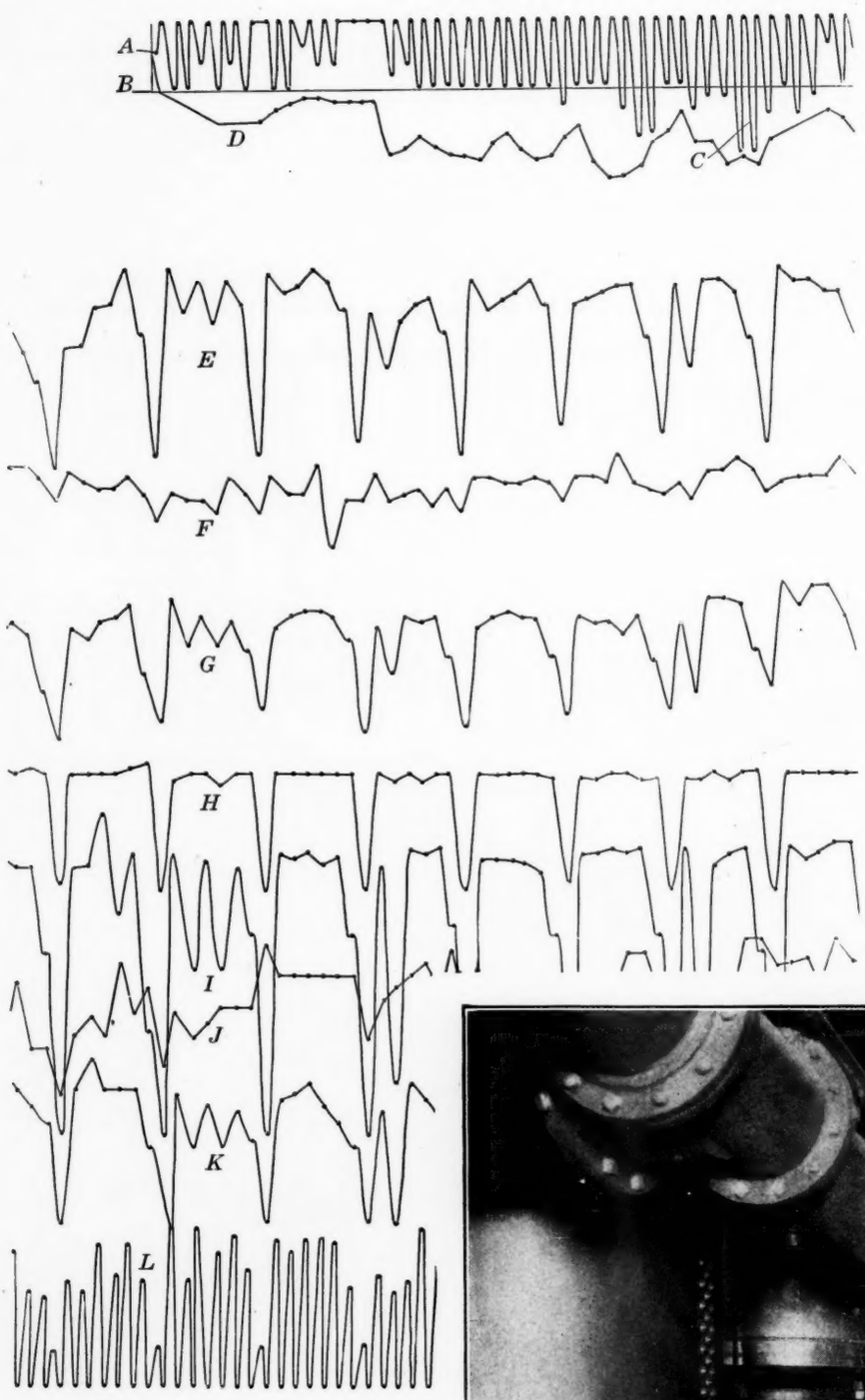

FIG. 5. EIGHT WEEKS' DAILY INDIVIDUAL SERVICE RECORD

rectors' room on the second floor, not only controls the entire tower-clock outfit, but about 100 other clocks throughout the building, as well as several program instruments for sounding various schedules of bells in the different departments.

"Through the medium of a special transmitter, minute impulses are sent to the tower-clock mechanisms on the twenty-sixth floor, keeping them in exact synchronism with the master clock; and at each quarter-hour electrical impulses are transmitted to the electric hammers on the forty-sixth story, and simultaneously are heard the notes of the old historic Cambridge chimes, composed by Handel.

"Simultaneously with the illumination of the hands and dials at night, an automatically actuated switch lights up a great electric octagonal lantern, 8 feet in diameter, located at the top of the tower, from which powerful electric flashlights, marking the hours in the evening, may be seen for a great distance, far beyond any possible transmission of sound, the time being signaled therefrom as follows:

"Each of the quarter-hours is flashed in red and the hours in white light. One red flash for the quarter, two red flashes for the half, three red flashes for three-quarters, and four red flashes for the even hour—these latter flashes followed by a number of white flashes marking the hour."

The lower floors are heated by an indirect system in which all of the air entering the rooms is drawn by fans from the court through screens and forced over and through the concealed radiators, furnishing a constant supply of pure, dustless air at all times. The upper floors are heated by a direct-radiation two-pipe exhaust-heating system into which live steam is automatically admitted whenever the demand exceeds the exhaust-steam supply. Circulation in the heating system is maintained by the vacuum pumps in the engine room.

As the modern office building is intended to be adapted to almost any kind of business a great variety of service is re-

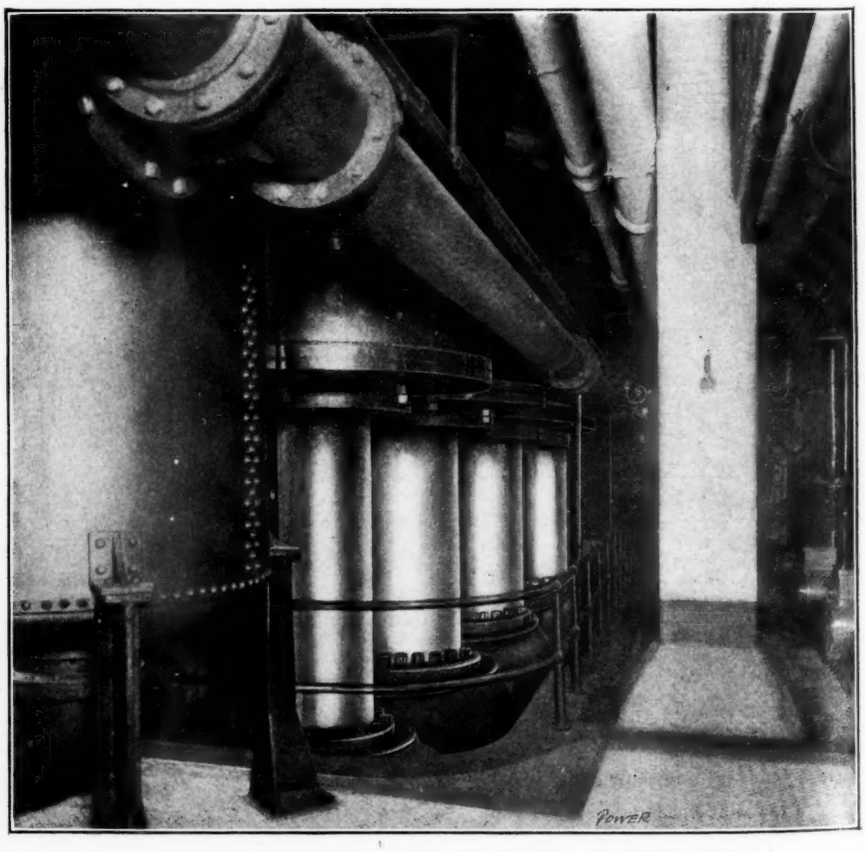

FIG. 6. A FEW OF THE 80-TON ACCUMULATORS

quired, and the Metropolitan is no exception. If it is different from others of its class, it is in the greater extent to which the diversity of service is carried.

The United States mail service requires compressed air for mail transmission to the extent of 250 horsepower. The restaurant and lunch rooms, where 2500 officers and employees of the company working in the building are furnished their daily noon-hour meal, demands steam, hot water, cold water and ice. The laundry has its unique equipment and a part of the work of the 40-ton refrigerating plant is the preservation of cold-stored furs from the destructive attacks of moths.

In plain sight of the firemen is an automatic Ados continuous CO_2 recorder.

One other detail of the plant that arrests the attention of the visiting engineer is a large steam-driven Richardson force-feed oil pump attached to one of the pillars in the ice-machine room with oil pipes supplying all of the cylinders in the refrigerating department. Other pumps of this type with single and double connections are used throughout the plant on all of the pumps and engines but this is the only one independently driven and supplying the requirements of a whole department.

Unlike many other engine rooms, visitors are always welcome, and for those who care only for a general or passing view, a visitors' gallery is provided which is reached by a short stairway leading from the arcade on the first floor. This gallery is a plate-glass room about 12x15 feet near the middle of the engine room. Through its transparent sides a good view may be had of the show part of every power plant—the engines and pumps.

Of the 38 passenger elevators 30 are hydraulic, with the cable-operating cylinders located on the floor of the subbasement, and eight are electric with the winding drums high up in the tower.

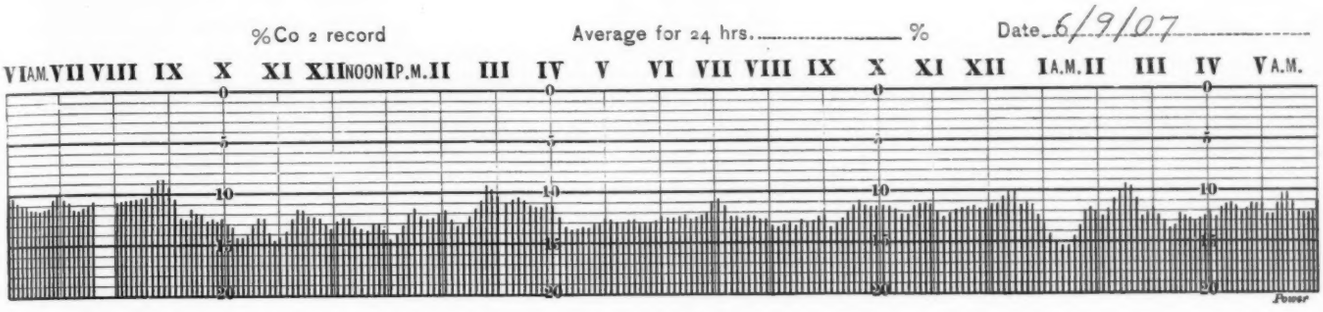
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FIG. 7. CHART FROM ADOS CO_2 RECORDER

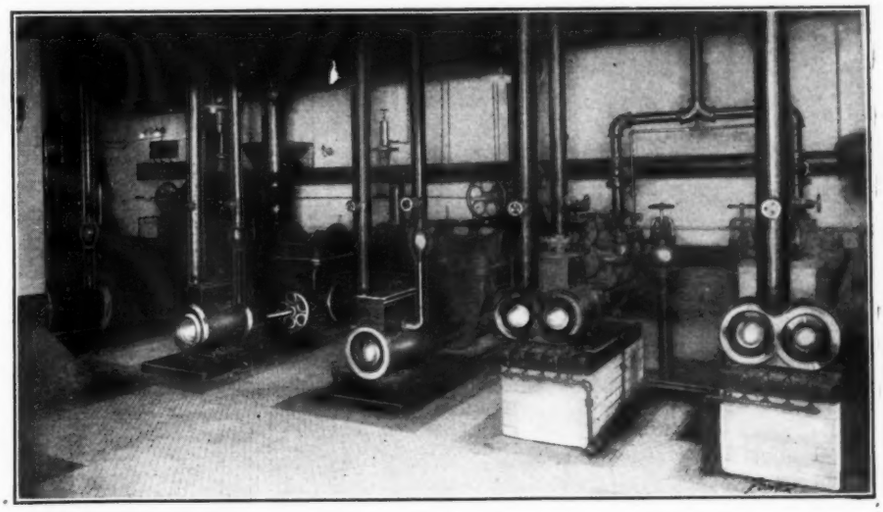


FIG. 8. AIR AND VACUUM PUMPS FOR HEATING SYSTEM

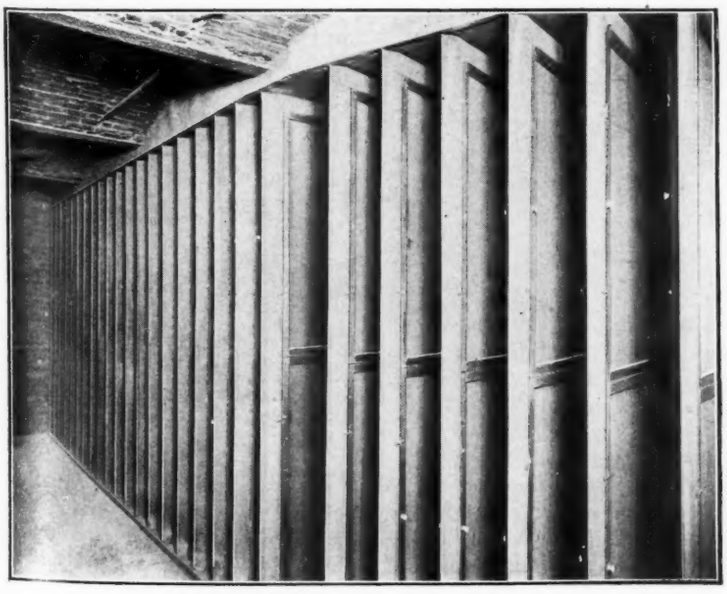


FIG. 9. AIR STRAINING SCREENS

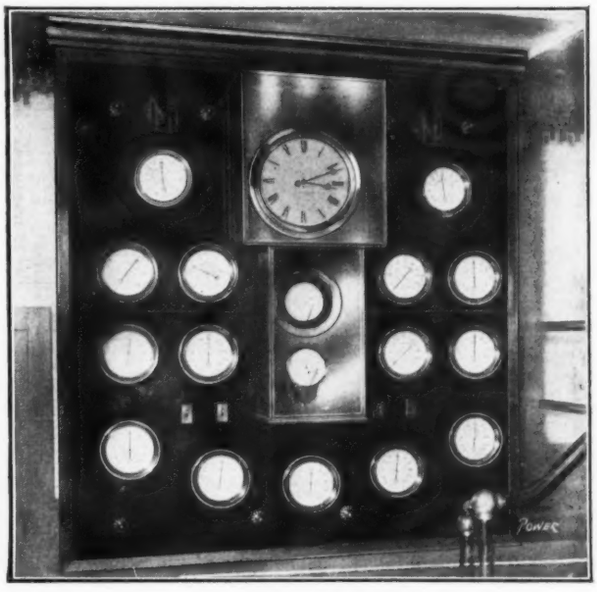


FIG. 10. GAGEBOARD

Setting Valves of a Williams Engine

By Hubert E. Collins

The valve used on the high-pressure cylinder of a Williams engine combines features of both a balanced slide valve and a piston valve. Its operation is illustrated and directions are given for its proper setting, together with the governor adjustment.

The valve herein described has some novel features which make it of prime interest to those interested in valves and valve motions.

It is a six-ported valve having four steam ports and two exhaust ports and is also balanced, working under two pressure plates, one at each end of the valve. Another feature is that it is an indirect valve, admitting steam over the inside edges and exhausting over the outside edges. The two end members of the valve are secured together by tubes which act as supplementary steam passages for admission; in other words, it combines the features of both a balanced slide valve and a piston valve.

This type of valve is adopted on Williams single-cylinder engines and on the high-pressure cylinders of the compound engines of that make, there being more of the latter than of the former in use. On the low-pressure cylinders the valves are of the gridiron type. These latter are similar in action to the McIntosh & Seymour type which has been frequently described. It is the purpose of the writer to treat only of the single valve used on the high-pressure cylinders.

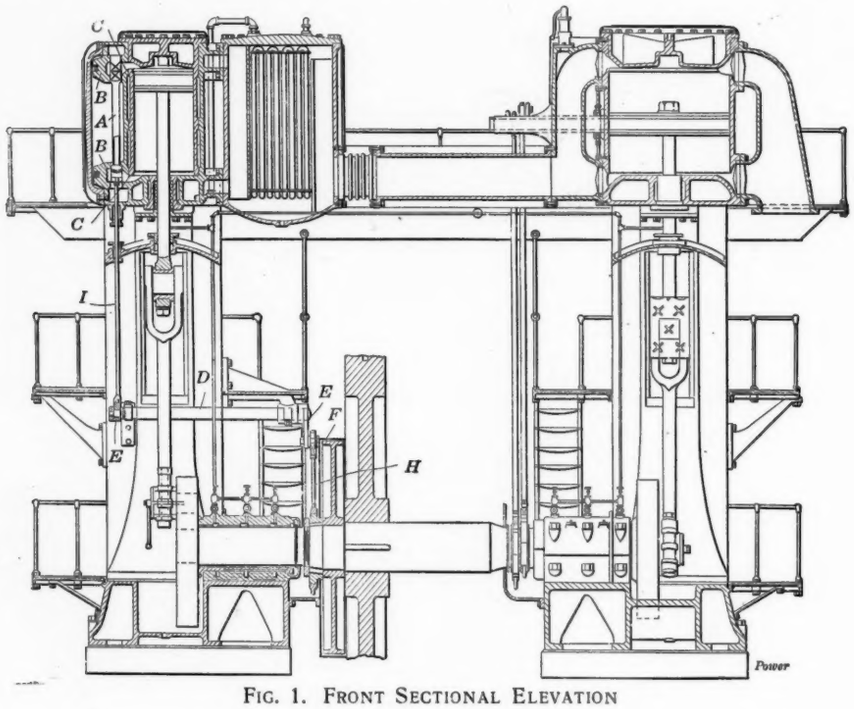


FIG. 1. FRONT SECTIONAL ELEVATION

The front sectional elevation of a Williams engine, Fig. 1, and the end elevation, Fig. 2, show the location of this valve and its driving mechanism.

In Fig. 1 the connecting tubes of the valve are shown at *A*, the ends of the valve under the pressure plates at *B*, the cylinder ports at *C*, the rocker shaft at *D*, the rocker arms at *E*, the governor casing at *F*, to which is attached the governor eccentric *G*, the eccentric rod at *H* and the valve stem at *I*.

Fig. 3 shows this valve and gear on the end of the shaft of a medium-speed engine, the same letters designating the corresponding parts shown in the first view.

Fig. 4 is a skeleton sketch with the valve in central position. The eccentric position is shown central at point *K*, and the eccentric positions for maximum and minimum cutoff are also indicated when the crank is on the top center.

The eccentric is in position to give maximum cutoff when the weight arm of the governor is on the inner stop, and minimum cutoff when the weight arm is at the outer stop. It will be noted that when the valve is central, the bottom exhaust edge is on a line with the port, while the top edge has a clearance or negative lap. *This peculiarity should be carefully noted.* In this, and succeeding figures, the valve is represented in a horizontal position for the purpose of convenience, but it should be remembered that it actually works in a vertical position.

Another peculiarity of this valve is the steam lap, which can be considered in two ways. For convenience we will call these lap *M* and lap *N*. The former is the distance the outside steam edge of the valve overlaps the steam edge of the cylinder port, while the latter is the amount the inside steam edges overlap the edges of the valve seat and pressure plate. It will be seen that the steam passes these alternate edges simultaneously. That this is an indirect valve and indirect motion is shown by the fact that the eccentric is advanced ahead of the crank and the valve travels in an opposite direction to that of the piston while admitting steam.

Fig. 5 shows the valve open for lead on the top center. The valve is open to the top port for the passage of steam direct from the steam chest and at the same time the bottom member of the valve has cleared the pressure plate and seat enough to admit steam through the tubes to the top port. The direction of steam flow is denoted by arrows, the exhaust flowing as indicated by the arrows on the bottom end.

Fig. 6 shows the valve full open to steam on the top end and exhaust on the bottom. In this position the eccentric has reached the extreme bottom of its travel while the crank is at 27 per cent. of its downward stroke.

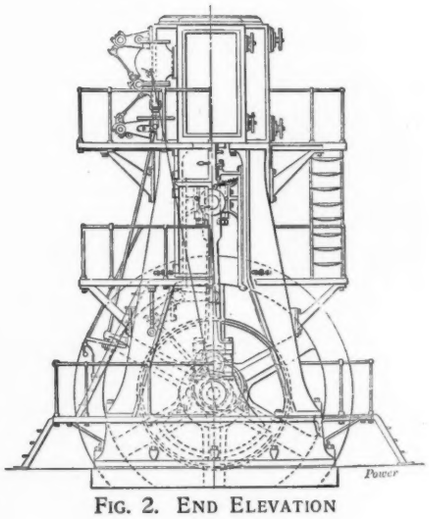


FIG. 2. END ELEVATION

Fig. 7 shows the valve at the point of cutoff on the top end. The crank has reached about 76 per cent. of its downward stroke and the exhaust on the bottom end is still open.

Fig. 8 shows the valve open for lead on the bottom crank center. It may be noted that on the eccentric circle the exhaust released on the top end at about 91 per cent. of the piston stroke and

closed on the bottom for compression at about 93 per cent.

Fig. 9 shows the valve full open to steam on the bottom end and to exhaust on the top with the crank at 22 per cent. of its upward stroke.

Fig. 10 shows the point of cutoff on the bottom end while still exhausting at the top. The crank is at 76 per cent.

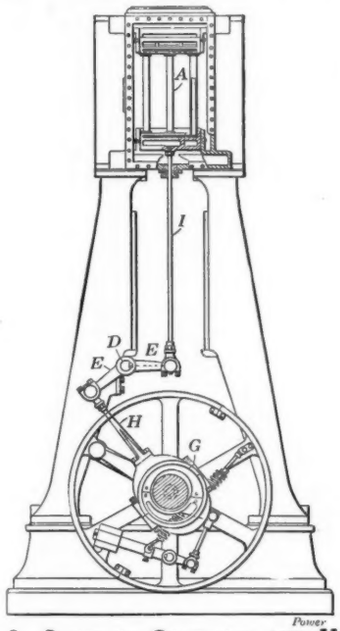


FIG. 3. SHOWING GOVERNOR AND HIGH-PRESSURE VALVE

of its upward stroke. A continuation of the operation will show that exhaust released on the bottom at 94 per cent. of the stroke and closed on top at 96 per cent.

SUMMARY OF VALVE ACTION

To briefly summarize this valve action it will be noted that the lead is about the same on the bottom and top crank centers with the variation in exhaust action shown in the following table:

Valve Action.	Full Open, Per Cent.	Cutoff, Per Cent.	Exhaust-Release, Per Cent.	Exhaust-closure, Per Cent.
Top end....	27	76	91	96
Bottom end.	22	76	94	93

Owing to the type of valve motion, the valve can have even steam lap and negative exhaust lap on the top end to give the desired steam distribution and balance the inertia of the moving parts.

TO SET THE VALVE

The governor eccentric which operates this valve is fastened to the governor wheel or casing, and the casing, in turn, is fastened to the shaft with a friction key. By slacking on the key set screws, hub and rim bolts the wheel with the eccentric can be revolved around the shaft.

It should be borne in mind that the preliminary valve setting should be performed with all valve motion connected and the governor weight arm on its inner stop or in a position to give maximum cutoff. For convenience, remove the steam-chest cover and pressure plates. Then test the valve for lap by turning the governor around until the bottom edge of the valve comes on a line with the lower edge of the bottom cylinder port. Then note if the steam edges of the valve are equidistant from the edges of the valve seats nearest the cylinder center. There will be exhaust opening on the top and the valve should be in the position shown in Fig. 4. Again test the correct length of the valve by moving it up until the bottom edge on the top of the valve is in line with the bottom edge of the top cylinder port, and note if the top edge of the bottom steam port is in line with the top edge of the bottom valve seat.

Next, test the valve for equal travel, up and down. As the bottom exhaust edge of the valve is on a line with the lower edge of the bottom cylinder port when the valve is central, it is plain that this exhaust edge should travel an equal distance above and below this port edge during one revolution of the eccentric. Also, this valve travel should be equal with the rocker arm, to which the valve stem is attached, traveling an equal distance above and below the center line of the rock shaft as shown by the dotted lines in Fig. 4.

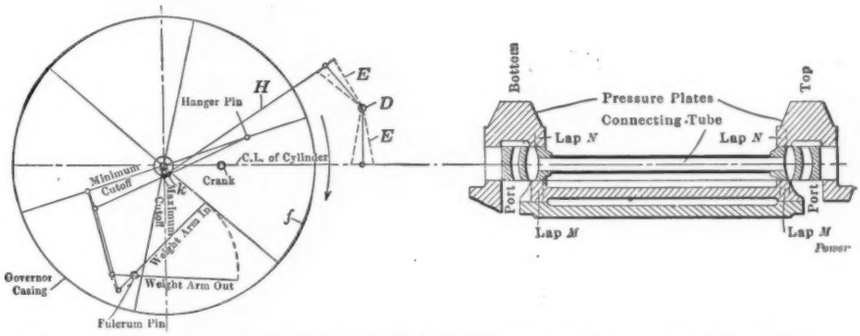


FIG. 4. MID-POSITION OF VALVE AND CORRESPONDING POSITION OF ECCENTRIC

Now place the engine on one center and set the valve for lead on that end and then on the opposite end, making the lead the same on both ends. About ⅛-inch lead is correct on sizes of 300 to 800 horsepower.

After setting the valve, secure the governor casing in place by taking up on the hub and rim bolts and finally the key set screws. When the governor casing is in place turn the engine to the top center and note the position of the governor in relation to the crank. It will be noted that the eccentric leads the crank by about 90 degrees. The hanger pin from which the eccentric is suspended will be between the eccentric rod and the crank center nearest the eccentric rod as in Fig. 4.

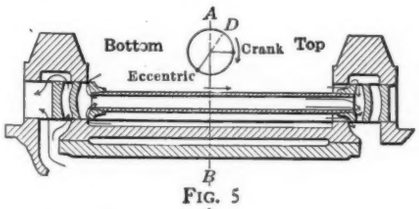


FIG. 5

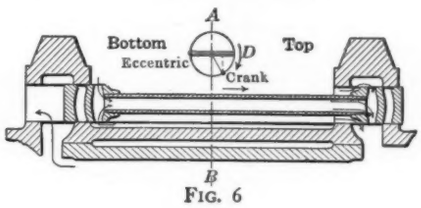


FIG. 6

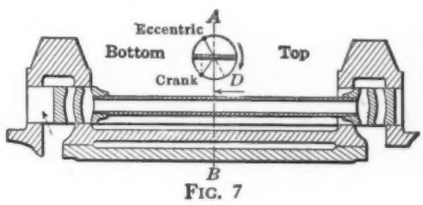


FIG. 7

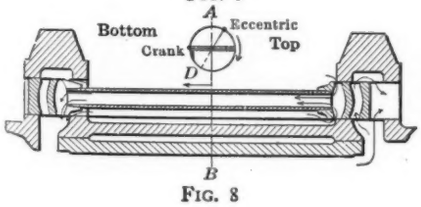


FIG. 8

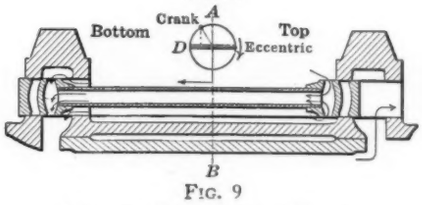


FIG. 9

VARIOUS POSITIONS OF VALVE

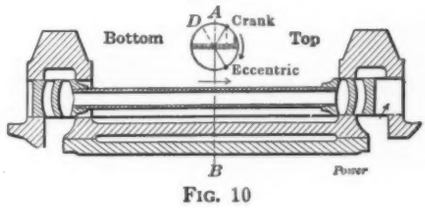


FIG. 10

Remove the governor spring and block the weight against its outer stop and while turning the engine a complete revolution note that the valve does not open for steam admission at any point of the revolution. This can best be observed with the pressure plates in position. No opening should show between the bridges

of the valve nearest the steam side and the edge of the pressure plates. After this point has been reached in the process of valve setting, everything should be marked so that any slippage or changes can be noted.

Governor Adjustment

The Williams governor is centrifugal in type and is of the class that throws the eccentric across the shaft center, varying the length of valve travel. The governor has two weight arms, one on each side of the spoke in which the pivot pin has a bearing. The force of the weights is opposed by two springs, one to each weight arm. The springs are fastened to the weight arm with a movable clip so that more or less purchase can be given the springs on the weight arm. The weights can also be moved along the weight arms to give more or less centrifugal effect. To move the weights in toward the pivot pin has the effect of less weight; to move the weights out has the effect of more weight. To move the spring clips on the weight arm in toward the pivot has the effect of more weight; to move the spring clips out has the effect of less weight.

To obtain more speed on the engine, give more tension on the springs until the racing point is reached, then to get more speed take away the weight, and to decrease the speed, add weight. Changes on the springs affect the speed and sensitiveness. Changes in weights affect the speed principally. Make all changes alike on springs and weights.

A Centrifugal Pump Experience

By W. N. Wing

In a certain plant two centrifugal pumps refused to pick up the water. Every expedient was tried to make them work, but the pumps would not throw a drop until they took the notion, and then of their own accord.

Some time ago I was sent to a small plant a few miles from the large city where I was located. It consisted of two centrifugal pumps, direct-connected to two vertical engines which were run at about 300 revolutions per minute. The size of the pumps was 10-inch discharge and 12-inch suction. Each pump was connected by a separate suction into the main suction pipe of 16 inches in diameter, which extended both ways from the engines, about 300 feet each way. From this main, short branches about 30 feet apart were connected to driven wells, about 20 in all. The water level in the wells, was, according to test wells situated at different points on the line, about 14 feet from the surface. The plant was shut down and it was stated that the pumps would not pick up the water.

I describe the layout of the plant to show the arrangement of the piping. The two pumps were side by side, about 12 feet apart, with the back sides of the pumps, which were connected with side-entrance suctions, next to the wall. The discharge pipe extended vertically from the pump about 9 feet and then turned with a long-sweep elbow and extended through the wall and into a wooden trough about 15 feet away where it discharged. On the end of each discharge pipe was a leather-seated clapper valve. Out of the top of each pump was a 4-inch pipe with a valve, and these pipes had a rise of about 2 feet and then turned and came together with a tee in the center, looking up. From this tee another riser was put in, about 4 feet long, and at the top of this was another tee, one end of which was connected to a 2- or 2½-inch siphon and the other to a discharge pipe for the siphon. The method of operation was to close the suction valve of one pump and then open the siphon, which would close the clapper valve and remove the air from the suction line, thus forming a vacuum and causing the water to rise in the pump. It should be said that only one pump was operated at a time.

The engine was started and put up to speed and the trick was supposed to be done, but, on the contrary, the pump refused to work. Then came the hunt for trouble. First we had a tryout of every joint in the engine room, and the clapper valve, by closing the suction valve and starting the siphon, and everything proved to be tight after a close examination. Nothing remained then but the main suction line and the branch lines to the wells, and these, after starting the siphon, were carefully examined. A small leak was discovered in one of the joints, and immediately made tight, but no cause was found to prevent the pump from working. We tried again but the pump absolutely refused to throw water. The engineer made a few extemporaneous and (as I thought) well chosen remarks to the pumps and we tried again. This time we started the other pump, but it wouldn't throw water, so we tried first one and then the other, and then both together, with the siphon on both, and while the siphon threw a 4-inch solid stream of water, those blessed pumps wouldn't throw a drop.

It was discouraging and I was about ready to give it up, as we had examined the impeller in the pump as about the last resort, when it occurred to me that some one of those wells might be dry or the pipes broken. The main suction had a valve between the two pump suctions and this was closed and the siphon put on the one side, and then each well was tried separately on both sides of the pipe line. Another hope was gone, as they all proved to be all right. In the meantime all these trials and suggestions had taken a few days. The water level in the wells had risen about a foot.

One morning I decided to "try her out" once more, so the engine was started after the siphon had picked the water up, and we stood around to see what the result would be, but there was nothing doing. Then, not knowing what to do, I opened the valve to the siphon on the pump that was standing, and closed it on the one running, when to my surprise the engine seemed to be getting the water, and upon opening the petcock on top of the pump the water squirted about two feet into the air, and yet no water was discharged at the end of the pipe. Now then, said I, we have it. The pump wants more speed. So we shut down and moved the regulator weights (it was a flywheel governor) for more speed, and started again and she would not throw a drop of water. Then we put her back to her regular speed, and tried again, and opened the siphon first on the running pump and then on the idle one, then both together, and then one and then the other again, and I had just opened it on the idle pump and closed it on the one running when the engineer called me to the window. While we were talking there came a thud from the engine. We turned and she was "on the job," throwing a solid 10-inch stream of water. We just looked at each other, and the engineer exclaimed: "Well, I'll be ———." He expressed my feelings to a nicety. Well, we let her go at that, concluding that she had decided to go to work.

This happened a few years ago, and I have been told that they always have the same trouble in starting those pumps. They are never sure whether they can start them, and engineers have been there who never could start them. It has always been an unanswered question in my mind what the trouble really was, and I have mentioned it to a great many engineers, all of whom had suggestions to make, and yet none was ever made that we didn't try; so it has never been as I said at first, settled to my satisfaction. It was a case where a prescription from a P. D. (pump doctor) that would effect a cure would be worth several silver dollars.

Blowoff Cocks for Steam Boilers

By Charles J. Simeon

Originally the plain plug cock was used for blowoff purposes, but it proved unsatisfactory for such service. The developments that have been made in improving its design are illustrated herewith.

When the first boiler was made some device was needed to allow the blowing out of mud and loose scale left by the evaporation of the water. In the beginning, steam pressures were low, and steam and water fittings as they are

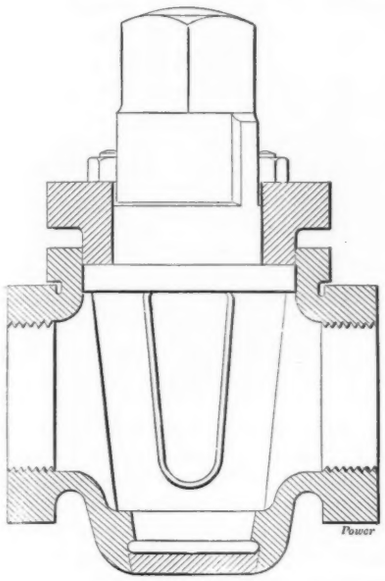


FIG. 1. FAIRBANKS

known today, were primitive and clumsy or nonexistent. Since that time the demands for high pressures and the better understanding of the requirements have directed a great deal of inventive ability toward the design of special appliances suited to the conditions. These have to handle not only steam and water, but loose scale, mud and such other matter as enters the boiler with the feed water, including boiler compounds and home-made scale solvents.

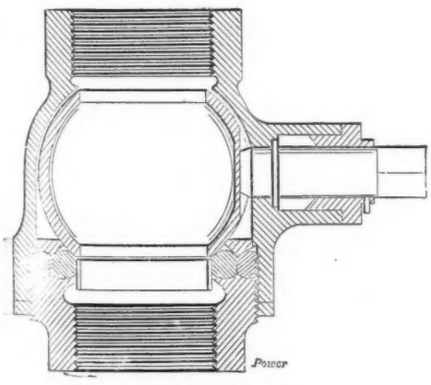


FIG. 2. HUXLEY

No feed water is pure, and all impurities not deposited and adhering to the shell and tubes must pass out through the blowoff in a more or less concentrated form. The solid portions made up of grit and pieces of scale are liable to adhere to the working faces of the cock and to choke or clog restricted passages. On account of their usually isolated and somewhat inaccessible location the blowoff is often more neglected than any other detail in the steam-power plant, despite the fact that, owing to the severe nature of the work done, it is

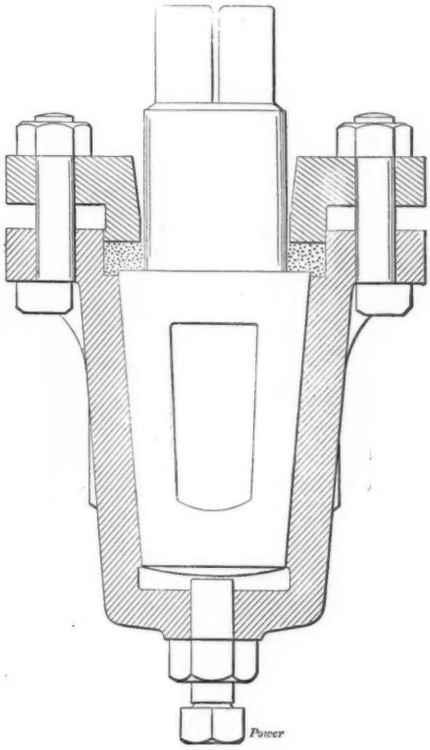


FIG. 3. WICKES

more apt to need attention than any other appliance.

Most men will handle steam apparatus with care because they have a healthy respect for live steam under pressure, but many will be careless in operating water valves and cocks. If one sticks the first impulse is to resort to the use of a hammer or a long wrench, with the possibility of personal injury or damage to the fitting, if this impulse is not checked. It is axiomatic that violence should never be used in operating any steam or water apparatus, but it is especially true of the boiler and all its connections. Too rapid opening or closing of the blowoff may be a fruitful source of trouble. A water-hammer action may be set up which will strain or break the pipe or some of the fittings or a bit of hard scale may be caught in such a way as to cause cutting and subsequent leaking, while if care is exercised, the obstruction may possibly

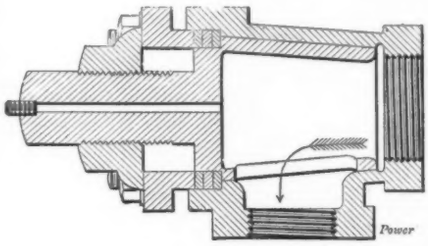


FIG. 4. SHAW

be felt and coaxed out by patient manipulation.

Some appliances, excellent for other service, fail when used in the blowoff because the design or the material used is unsuitable. A valve or cock that is easily choked or the working faces of which are exposed to the cutting action of the flow is wrong in design, and one which may be affected by the impurities in the water or is not tough enough to stand the cutting action of the stream of dirty water passing through it, is made of the wrong material. In many designs the aim to overcome these difficulties is shown in ample clearances, unobstructed passages, massive proportions and in the use of the strongest and toughest material available.

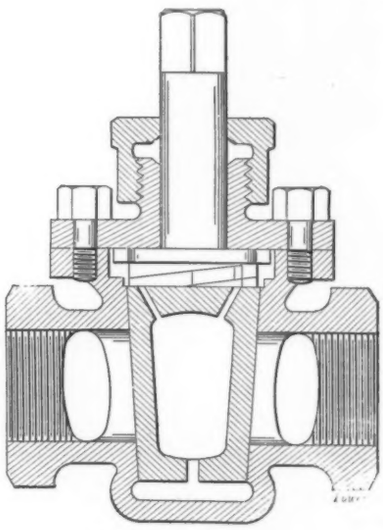


FIG. 5. HOMESTEAD

The first appliance used for the blowoff was the ordinary brass plug cock, because it was the only thing available. It is still used by many engineers on account of its simplicity and cheapness, but by others it is considered unsuitable because mud and scale come to rest against and adhere to the plug, and when it is

turned they are carried with it, cutting the faces of both plug and body, causing it to stick and leak. Also when it is closed, the sides of the plug and the body nearest to the boiler are exposed

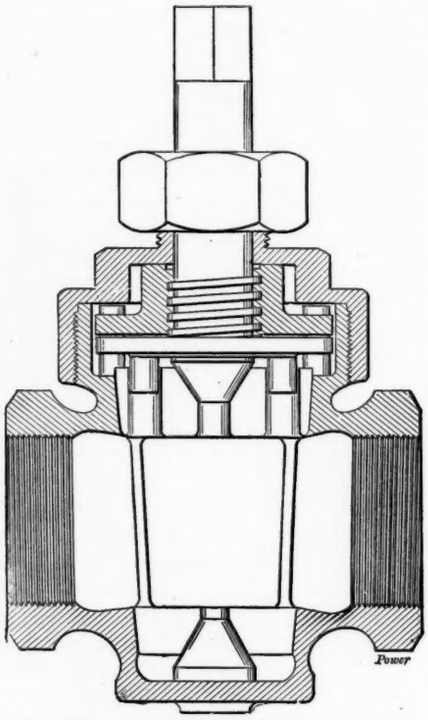


FIG. 6. CADMAN

to a higher temperature, which causes an unequal expansion, warps both members and makes the plug stick in the socket.

Developments of the plug cock have been numerous and along different lines. The first variation took the form of an iron plug in a brass body which was less liable to stick from uneven expansion

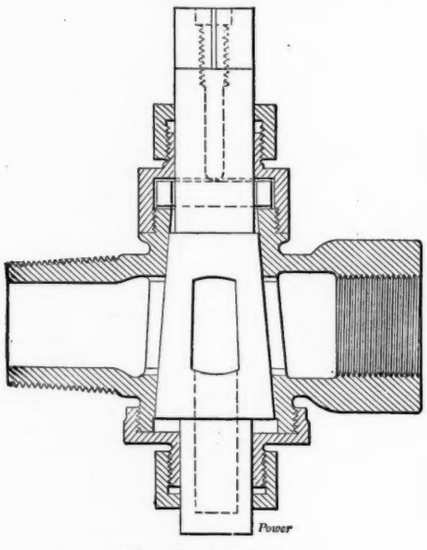


FIG. 7. ANDERSON

than one made entirely from one metal. This, however, was not a great success, owing to the rusting of the iron plug and the high cost of the brass body. One made with an iron body and a brass plug though cheaper, was impracticable for the very reasons that made the other a partial success. Then one was tried in which both the body and the plug were of iron, given an anti-rust treatment which reduced the tendency to stick and cut. This form is still used to a large extent.

The next step was, in addition to the anti-rust treatment, to make the seat of some material more pliable than iron or brass. The Fairbanks asbestos-packed cock, Fig. 1, is an example of this type in which a barffed-iron plug works in a socket of specially prepared asbestos forced into position by hydraulic pressure. It has a vulcabeston ring on the shoulder of the plug for a top packing.

The Huxley, Fig. 2, is somewhat similar in character. It is a plug cock in which the plug takes the form of a hollow sphere while the seat is formed by a layer of soft packing that is pressed into intimate contact with the spherical

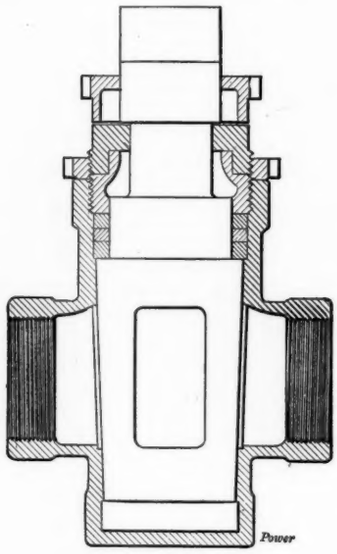


FIG. 8. BORDO

surface of the plug by means of a screwed gland.

The next successful cocks are of the type in which a mechanical device is used for loosening the plug in its socket, thus allowing it to move with ease and yet be tight when closed. The Wickes, Fig. 3; Shaw, Fig. 4; Homestead, Fig. 5; Cadman "Split-plug," Fig. 6; Anderson, Fig. 7; Bordo, Fig. 8; the Wiltbonco, Fig. 9, and the Ashton, Fig. 10, are examples of this type.

The Wickes is provided with a set screw and lock nut which permits adjustment of the plug to any degree of tightness desired or readily loosening it if it should stick. The Shaw has a large nut working on the stem of the plug for the same purpose. In these two the adjustment of the plug must be deliberately made.

The Anderson, Homestead, Bordo and Cadman also provide for adjusting the tightness of the plug in its socket, but the loosening or tightening is done automatically in the act of operating. In the Anderson this is effected by means of two rollers that revolve on a shaft passing

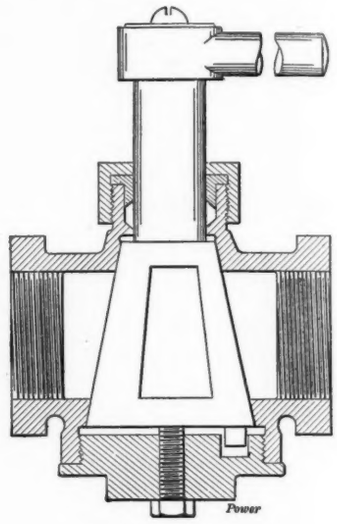


FIG. 9. WILTBONCO

through the stem of the plug and run up inclined planes cut in the body. A movement in one direction loosens the plug in its seat and locks it open, while a reverse movement tightens it and locks it closed. The Homestead attains the same results by means of a spiral cam. The Shaw is an example of a cock in which an attempt is made to keep the gritty sediment contained in the water from resting on the working surfaces when closed. To attain this the inlet is made at the small end of the plug and the outlet at one side, pointing downward. When so placed, any sediment from the boiler collects inside and is blown out when opened, instead of coming to rest against the ground surface of the plug.

The above steps trace the development

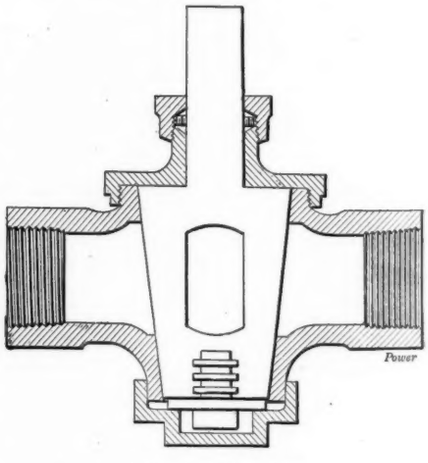


FIG. 10. ASHTON

of the plug cock, which was the first piece of apparatus used for this purpose and is by many engineers still preferred to any other, owing to its simplicity and cheapness.

Operation of Compression System

By F. E. Matthews

The cycle of operation is thoroughly explained, beginning with the introduction of the ammonia into the expansion coils, following it through the compressor up to the condenser and its return by way of the liquid receiver to the expansion coils.

While it is impossible to show in a single illustration all the details entering into the mechanical construction of the complete refrigerating system, the diagrammatic representation presented is more complete than the elementary diagrams already shown, and will suffice for the explanation of the cycle of operation of the compression system.

The cycle begins with liquid anhydrous ammonia conducted to the expansion coils through a liquid line and regulated by appropriate expansion valves. The source of the liquid ammonia may be either a liquid receiver, which, as already shown, is one of the essential members of the system in practical operation; or it may be an ammonia-shipping drum from which ammonia is introduced into the system by the process of charging. In either case the first function of the refrigerant is to enter the expansion coils in the compartment to be refrigerated and there to evaporate (boiling at a temperature dependent on the suction or "back pressure" within the coils) and absorb heat from the surrounding objects. If the back pressure be 46 pounds gage, or less, the temperature of the boiling liquid will be 32 degrees Fahrenheit, the freezing point of water, or below, and the pipes containing the refrigerating medium at these temperatures will soon be covered with a coating of frost. If, on the other hand, the back pressure in the coils is above 46 pounds gage, the temperature of the boiling liquid will be above 32 degrees Fahrenheit, and no frost will be formed. Refrigeration will be produced whenever the temperature of the expansion coils is lower than that of the air in the cooler, regardless of whether frost is formed or not and, according to the amount of atmospheric humidity, uncongealed moisture may or may not be precipitated on the pipes.

Having vaporized in the expansion coils, the ammonia vapor enters the return header which conveys it back to the suction side of the compressor. This return line is usually fitted with a "scale trap" constructed similarly to a simple steam separator. The function of this trap is to prevent any scale from the inside of the pipes, or other foreign substance, from entering and damaging the compressor. From the scale trap the gas passes through the suction valves into the compressor.

On leaving the compressor the hot, high-pressure ammonia gas passes through the discharge valves and out into the two legs of the main discharge pipe, which come together in a "T" just below the large hand-operated discharge valve at the left-hand side of the compressor cylinder. Leaving the discharge valve, the gas passes into the side of the pressure-tank head, and is given a spiral motion as it descends into the tank. The centrifugal force produced by this spiral motion is intended to aid in precipitating any entrained oil which the gas may hold in suspension, against the outside of the tank. The gas then passes up through the hot gas line, through a "check valve" (sometimes omitted) located a little above the level of the top of the condenser, and down into the header connecting the bottom pipes of the several stands of condensers. The loop is placed in the hot-gas line to prevent condensing liquid from running back down into the pressure tank when the compressor is shut down.

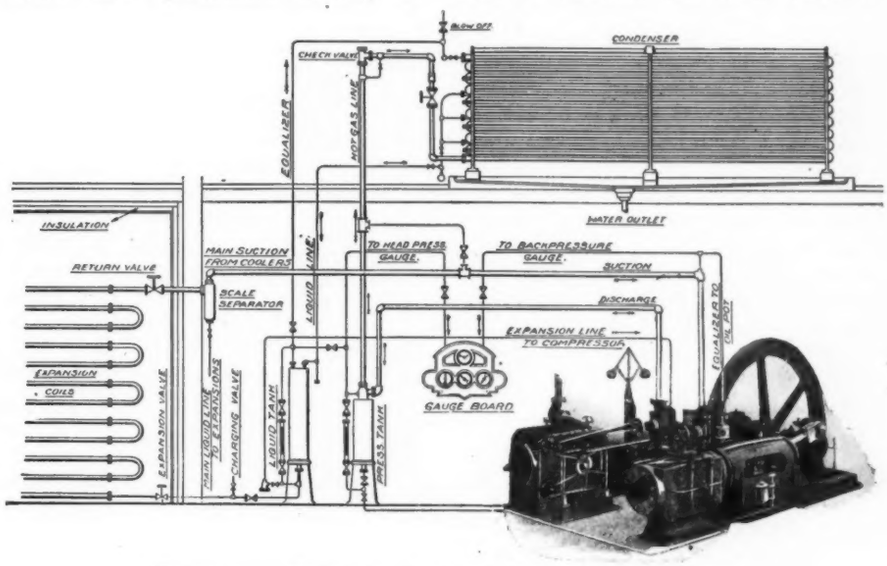


DIAGRAM OF COMPLETE AMMONIA REFRIGERATING SYSTEM

The gas entering the bottom pipe of the condenser passes up through successive pipes while the water distributed over the top pipe trickles down, producing the desirable countercurrent cooling effect, in which the hottest water encounters the hottest gas at the bottom and the coolest water the coolest gas at the top of the condenser.

As fast as the ammonia is condensed in the pipes of the condenser it is conducted away through smaller liquid-drip pipes connected with a common liquid header. The outlet from this header also rises to form a short "goose-neck" which is intended to keep the header always full of liquid and prevents gas from being drawn down to the tank through the liquid line. In trying to ascend through the column of descending liquid in a small liquid line, bubbles of gas offer no inconsiderable resistance to the passage of the liquid. The obvious remedy for this difficulty is the installation of lines of liberal diameter.

If the gas is carried down into the liquid tank it can escape by going up the equalizer line into the top of the condenser. The ammonia previously liquefied in the condenser under a pressure of from 135 to 200 pounds, according to the temperature of the cooling water, is conveyed first to the receiver. This consists of an appropriate cylindrical containing vessel which acts as a storage tank in which the liquefied ammonia is collected and from which it passes as required into the expansion coils. The flow of this high-pressure liquid into the expansion coils is regulated by expansion valves, which are virtually nothing more than convenient mechanical devices for accurately varying the opening through which the liquid ammonia must pass on its way to the expansion coils. As stated, the word "expansion" has been erroneously applied to these valves and coils, because of the idea, also erroneous, that the liquid ammonia vaporizes or expands immediately when the pressure is relieved, as it passes the regulating valve and enters the cooling coils. As a matter of fact, before it is possible for a pound of ammonia to change from the liquid to the gaseous state it must be supplied with about 555.5 B.t.u. of heat.

In practice, not all of the heat-absorbing

capacity, or negative heat, of a pound of anhydrous ammonia available at zero Fahrenheit can be utilized for useful cooling work, on account of the cooling work which must first be expended on the ammonia itself in order to reduce its temperature from that of the condenser to that of the cooler. This may be illustrated by a similar process in which water is the medium. The amount of heat that must be abstracted from one pound of water at 32 degrees Fahrenheit in order to freeze it, is 144 B.t.u. On this basis, a ton of ice would represent 288,000 B.t.u. of negative heat. In practice, the expenditure of this amount of cooling will not freeze a ton of water, because it must first be reduced from its natural temperature, or, in crystal-ice systems, from the temperature of the distilling tank to 32 degrees Fahrenheit. This involves a further expenditure of one negative B.t.u. per pound per degree of temperature.

If the 555.5 B.t.u. were absorbed at the expansion valve, which its immediate vaporization assumes, there would be no further heat-absorbing capacity in the ammonia, and its introduction into the expansion coils would be useless.

Besides the principal pipe circuit just described, the compressor is provided with a set of bypass connections for reversing its operation so as to draw the ammonia from the condenser and discharge it into the expansion coils, as well as other so called "pump-out" lines through which ammonia may be pumped out of other parts of the system in case it becomes necessary, as when making repairs.

In the figure is shown a small liquid line running from the liquid tank to the compressor cylinder. This line is provided with an expansion valve through which ammonia may be admitted to the compressor, to prevent abnormal heating of the piston and packing when starting up, or at any other time when the ammonia returning to the compressor is not sufficiently cold to insure satisfactory operation of the compressor. Another small pipe line connects the lubricating system on the compressor with the pressure tank. Through this line oil passing over with the discharged ammonia gas and separated out in the pressure tank, may be blown back into the lubricating system. On entering this line the oil passes first through a small strainer which intercepts any scale or foreign substances that might otherwise return to the compressor.

Details of construction of the various parts of a compression system are too numerous to warrant an attempt to fully describe them here. Since the ammonia compressor is so important a member of the refrigerating system, a subsequent article will be devoted to defining and illustrating the two principal types, namely, the horizontal double-acting and the vertical single-acting compressor.

An Improved Hatchet Planimeter

By Frank S. Bunker

The general theory and operation of planimeters are explained and a description is given of an improved form of hatchet planimeter whereby the plane of the tracing arm is kept constantly at right angles to the surface of the area to be measured.

Among the instruments used by steam engineers the planimeter is second in importance only to the steam-engine indicator. In the offices of designers, architects, civil engineers, the planimeter has a place as honored and as essential as the oil can has in an engine room. By its use the designer is able to quickly obtain the cross-sectional area of any irregular object, and thus obtain the contents and weight without involving tedious calculation. The civil engineer uses it on his maps and obtains areas which would require a long time to calculate.

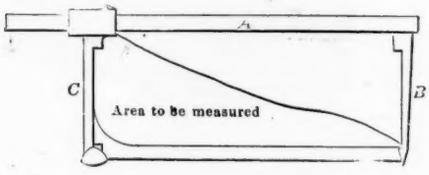


FIG. 1. SIMPLE FORM OF HATCHET PLANIMETER

The designs of planimeters are almost as varied as their uses. Some styles are better for certain fields of application than others, but the underlying principles of all types of planimeter are the same and one general theorem applies to all.

THE HATCHET PLANIMETER

One of the simplest forms is the hatchet planimeter, often called the Stang-Prytz-Goodman planimeter. This is shown in Fig. 1 and consists of a bar *A* at the extremity of which is a rigid arm *B*, the latter being the tracer. Sliding along the bar *A* is another arm *C*, the lower edge of which is shaped like a hatchet, the edge corresponding to the cutting edge being in perfect alinement with the tracer *B*. The arm *C* is adjustable along the main bar and is clamped in place by a spring. When in use, the adjustable arm is shifted along the bar to a position at which the two arms just encompass the length of the figure to be measured. The center of gravity of the area to be measured is roughly ascertained and a line is drawn from it to the edge of the figure, preferably parallel to its longest dimension or parallel to the atmospheric line in an indicator diagram; see dotted line *E E'*, Fig. 2. With the tracer at *D* place the instrument approximately at right angles to the line *DE*. Press the hatchet end into the paper so as to make a depression at the starting point *F*. Now move the tracing point along the dotted line *DE* and trace around the area, returning to the starting point *D*. It is preferable always to trace diagrams in a clockwise direction at the first operation. Now press the hatchet again as at *G*. If the point *D* were the exact center of gravity then the distance between *F* and *G* would be the mean hight of the diagram, but the point *D* was selected according to the operator's judgment and is therefore only approximate.

Still holding the tracer at *D* turn the diagram through approximately 180 degrees and retrace the area in the opposite direction (counter clockwise) and when in the final position press the hatchet as at *H*. A point *J*, midway between *H* and *G*, is now found, and its distance from *F* is the average or mean hight of the figure. If the figure be an indicator diagram, this mean hight multiplied by the scale of the spring will give the mean effective pressure.

The distortion of the correct positions of the points *H* and *G*, due to not holding the plane of the instrument at 90 degrees with the surface of the area being measured, led me to design and construct the instrument shown in Fig. 3.

This instrument carries an arm *K*, at the extremity of which is a small roller *L*, which is free to swivel in any direction and prevents the instrument from slipping sideways. I also substituted a wheel *M* having a knife edge in place of the hatchet end, and attached a small pointer *N;* this when pressed gives the

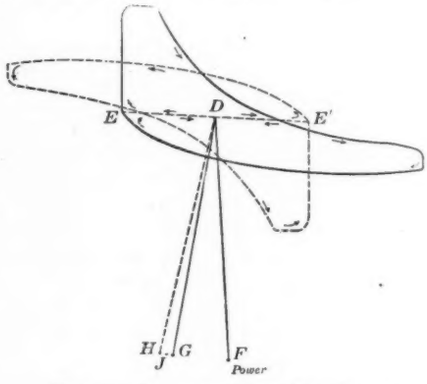


FIG. 2. OPERATION OF HATCHET PLANIMETER

required location of the starting and finishing positions *F*, *G* and *H*, Fig. 2. The small disks shown holding the card and on the instrument are used as weights to add to the stability of the instrument when in operation.

I have tested this planimeter with known areas and have found it to be as accurate as any of the more complicated and expensive planimeters.

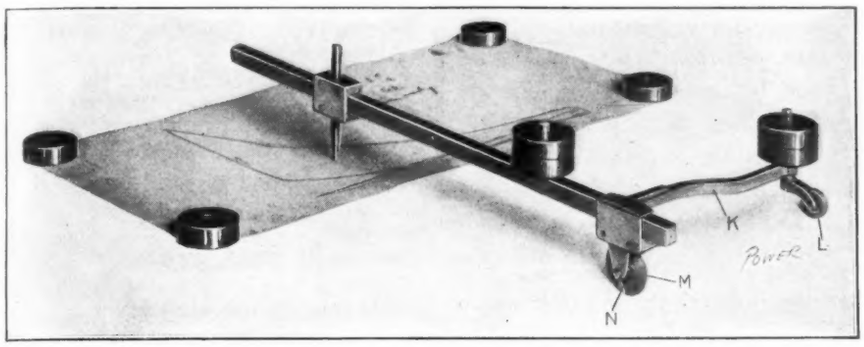


FIG. 3. IMPROVED HATCHET PLANIMETER

THEORY OF THE PLANIMETER

To Professor Henrici we are indebted for a discussion of the general theory upon which all planimeters are based, namely, that the net area swept over by the tracing arm equals the difference in the areas traced by the extremities of the arm. Hence in Fig. 4 the tracing point moves over the outline of the closed curve *O P Q R*, while the opposite end of the tracing arm moves over the outline of the lower closed figure *O' P' Q' R'*. Let the starting position of the tracing arm be *Q Q'* and let the tracing point move around the outline *Q P O* from right to left; then the other end of the arm will follow the outline of *Q' P' O'*. Continue until the tracing point comes back to the starting point *Q* and the follower will be at its initial position. The arm has now swept over the entire area *O P Q Q' R' O'*. The area *O R Q Q' P' O'* having been twice swept over by the tracing arm, once in a counter clockwise direction and again in the opposite direction, will cancel and there is left the area *O P Q R*, swept over in a positive direction, and *Q' P' O' R'* swept over in a negative direction. Hence the net area swept by the tracing arm equals the difference between the areas swept by the ends of the arm, that is, *O P Q R Q' P' O' R'*.

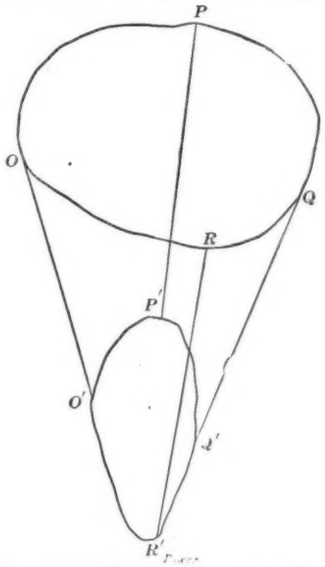


FIG. 4. AREA PASSED OVER BY TRACING ARM

With the Coffin and the Amsler planimeters the follower passes along a line without inclosing an area; therefore the difference between the areas swept over by the extremities of the tracing arm is the area of the figure traced. Following the same reasoning with the hatchet planimeter, the hatchet either goes over the same line in two different directions or sweeps the area partly in a positive direction and partly in a negative direction, and the net area swept over by the arm is the area of the figure traced.

The motion of the arm is one of translation along the arm and of rotation about the point of contact of the hatchet. As the former does not sweep over an area, the whole area moved over by the arm is therefore due to angular motion. In other words, a line the same length as the tracing arm, rotated about one of its extremities as a fixed point and always kept parallel to the tracing arm, will sweep through an area equal to that swept through by the tracing arm. Hence the area swept through by the tracing point is equal to the length of the tracing arm multiplied by one-half the length of the arc swept through by the tracing point.

Now proceed with a closed figure, as *S T U*, in Fig. 5. Let *U V* be the initial position of the tracing arm, *U* being the tracer and *V* the follower or hatchet. Trace the curve from *U* to *T* and *S* around to *U*. The follower will have traced the path outlined by *V W X*. Now draw *V U'* parallel to the final position *X U* of the tracing arm. The area swept by the arm is equal to the area of *U' V U* or one-half the length of the arm multiplied by the circular measure of the angle *U' V U*, which is the same as angle *V U X*. But the tracing arm has been set to the exact length of the figure to be measured; hence arc *V X* must equal the average or mean hight of the area.

To make sure that the area of the figure traced by the hatchet is zero, the point *W'* may be selected as the center of the area, and through *U* draw *U W'*. If when the tracing arm was in its first position *U V*, the tracing point had been moved from *U* to *W'* the hatchet would have followed the line *V Y* to *Y*, and the same may be said of the final position of the tracing arm *U X*; move the tracing point and the hatchet will follow the curve *X Z*. Now place the tracing point at *W'* and the hatchet at *Y* and move the former along from *W'* to *U*, then the hatchet will move from *Y* to *V*. Trace the figure as before, ending at *U* with the final position of the arm at *UX*. Move *U* along *U W'* and the hatchet will follow to *Z*. Swing the hatchet through the arc *Z Y* and if the center *W'* has been properly selected the area of the figure traced by the hatchet is zero, being generated half positively and half negatively. When this is so the net area whose outline was traced by the tracing point will be equal to the area swept over by the tracing arm, which is equal to *W' Y* × *Y Z*. If *W' Y* equals the length of the figure then *Y Z* must equal the mean hight.

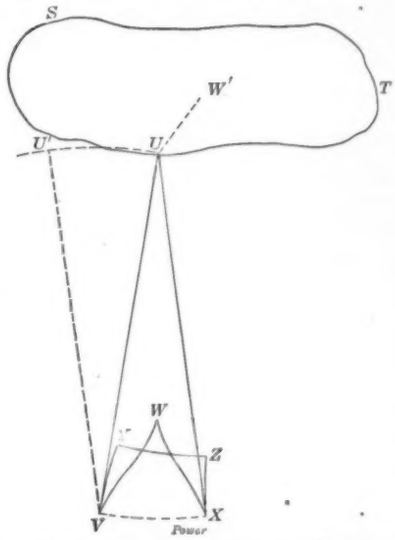


FIG. 5. DIAGRAM ILLUSTRATING PROOF OF THE THEORY UPON WHICH THE PLANIMETER IS BASED

To reduce the error due to a faulty location of the center of gravity after having once traced the area to be measured, turn it through 180 degrees and retrace in an opposite direction; then take the average between the two points as described in connection with Fig. 2.

Provided that care is taken in obtaining perfect alinement of the hatchet and the tracing point, the results are as satisfactory as those obtained by the most expensive planimeter.

The Right Angled Triangular Weir

By Charles N. Cross

This type of weir is better adapted to the measurement of small and variable quantities of water than the rectangular weir, and besides the quantity of water flowing becomes the function of only one variable—the head of water.

The word weir was first used in an engineering sense to designate an artificial obstruction placed in the bed of the stream. The weir was used to raise the level of the stream for purposes of irrigation, navigation or for power. Later, when it became the custom to specify the amount of water to be used at certain places, its measurement in large quantities was necessary. A rectangular hole was cut in the wall and the amount of water roughly gaged by the size of the opening. These rectangular notches were calibrated in various ways as the specifications became more exacting, and the openings were called weir notches and later simply weirs.

In 1858 James Thomson, professor of civil engineering, Queen's College, Belfast, suggested the use of the right-angled triangular notch with its apex pointing downward, to take the place of rectangular weirs, because the latter were not adapted to the measurement of small and

TABLE 1. CONSTANTS FOR WEIR DISCHARGE.

$q = c\,h^{\frac{5}{2}}$	$Q = C\,H^{\frac{5}{2}}$	$Q = \frac{8}{15} K H^{\frac{5}{2}} \sqrt{2g}$
$c = 0.317$	$C = 2.635$	$K = 0.6162$
$c = 0.306$	$C = 2.544$	$K = 0.5948$

variable quantities of water. Another advantage of the triangular notch given by Thomson is, that the quantity of water flowing becomes a function of only one variable, viz., the head of water; while in the rectangular notch it is a function of at least two quantities: the head and the horizontal width. Of course, the application of the triangular weir at the present time is rather limited. For some kinds of laboratory testing and for measuring small flows in irrigation work, it is very convenient.

Thomson reasoned that the flow must be proportional to the 5/2 power of the head, that is, the discharge is proportional to the product of the velocity of the water times its cross-sectional area. In Fig. 1 let

h = Head of water,

b = Width of notch at level of the water,

then the area of the notch filled is $\frac{1}{2}\,b\,h$; but in a right-angled triangle

$$b = 2h,$$

therefore,

$$\tfrac{1}{2}\,b\,h = h^2.$$

Theoretically the velocity of a body falling through a vertical distance h is,

$$\sqrt{2gh},$$

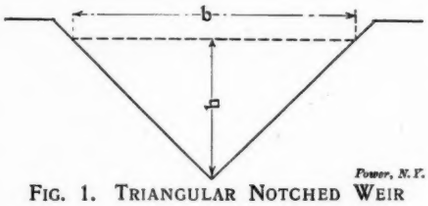
where g is the acceleration due to gravity and is about 32.16 at a latitude of 45 degrees. Therefore the theoretical discharge is,

$$q = h^2 \sqrt{2gh} = h^{\frac{5}{2}} \sqrt{2g}.$$

Thus the discharge is proportional to $h^{\frac{5}{2}}$. This reasoning of Thomson's was substantiated by more rigorous mathematical development later.

Now it remained to determine by experiment whether there was some constant which multiplied by $h^{\frac{5}{2}}$ would give the quantity of water discharged for all values of h, that is,

$$q = c\,h^{\frac{5}{2}}.$$



Power, N.Y.

FIG. 1. TRIANGULAR NOTCHED WEIR

After a limited number of trials and with h varying from 2 to 4 inches, the following expression was arrived at:

$$q = 0.317\,h^{\frac{5}{2}},$$

where

q = Cubic feet discharged per minute and

h = Head measured vertically in inches from the still-water level of the pool down to the vertex of the notch.

This is the formula which Thomson submitted to the British Association for the Advancement of Science in 1858. In his report he states that it is only a temporary formula subject to amendment depending upon more perfect experiments covering a wider range of heads. In 1861 Thomson presented his final report before the association, and it is published in the records of the society for that year. This report was the result of experiments extending over a period of two years and with heads of from 2 to 7 inches. The average of all these determinations for the coefficient was 0.3064. The formula was thus made to read,

$$q = 0.306 h^{\frac{5}{2}}.$$

Thomson himself gave it as,

$$q = 0.305\,h^{\frac{5}{2}},$$

because he gave somewhat more weight to certain experiments. But 0.306 would seem to be the logical value.

It is the present custom to measure all heads of water in feet, and weir discharges are usually measured in cubic feet per second, thus

$$Q = C\,H^{\frac{5}{2}}.$$

The coefficient reduced to give the result in these units will change the equation to,

$$Q = 2.544\,H^{\frac{5}{2}}.$$

Another form of this same equation is often used. It comes from a different theoretical treatment, and is as follows:

$$Q = \tfrac{8}{15}\,K H^{\frac{5}{2}} \sqrt{2g},$$

where K is the experimental coefficient; the value of K corresponding to 0.306 above is 0.5948. For convenience of comparison a table of these coefficients is given.

TABLE 2. WEIR CONSTANTS GIVEN BY VARIOUS AUTHORITIES.

Name of Author.	Title of Book.	Coefficient by Author.	Coefficient Corresponding in Thomson's Formula.
W. J. M. Rankine	Manual of Steam Engine, 3d edition, 1866, page 95.	2.645	0.3181
W. J. M. Rankine	Manual of Steam Engine, 8th edition, 1875, page 95. Revised by E. F. Bamber.	2.54	0.3055
Mansfield Merriman	Treatise on Hydraulics, 1889, page 127.	2.54	0.3055
S. Dunkerly	Hydraulics, Vol. I, 1907, page 20.	0.62	0.319
J. A. Ewing	Steam Engine and Other Heat Engines, 1902, page 211.	2.54	0.3055
Chas. H. Innes	Centrifugal Pumps and Turbines, 4th edition, page 6.	0.595	0.3061
John Goodman	Mechanics Applied to Engineering, 1904, page 561.	0.60 to 0.61	0.3087 to 0.3138
Henry T. Bovey	Hydraulics, 1895 edition, page 56.	0.617	0.3174
R. G. Blaine	Hydraulic Machinery, 1897 edition, page 76.	0.317	0.317
Irving P. Church	Mechanics of Engineering, 1893 edition, page 676.	0.595	0.3061
L. M. Hoskins	Text Book on Hydraulics, 1907 edition, page 153.	0.592 or 2.54	0.3045 or 0.3055
Herbert M. Wilson	Irrigating Engineering, 1907 edition, page 86.	2.54	0.3055

All of the values given in Table 1 and some besides have been used by different authors in referring to Thomson's result, as may be noted in Table 2 which contains a partial list of those who have mentioned this type of weir. An inspection of this list, and it was selected without any particular discrimination, shows that nearly one-half of the authors who quote Thomson either directly or indirectly use coefficients in the neighbor-

hood of the value determined in his preliminary experiments, while the other half use values in the neighborhood of his final result.

It is remarkable that a constant derived in a set of experiments by one man can have so many variations. However, there may be some reason for these seeming discrepancies. Thomson arrived at the conclusion that the coefficient must be very nearly a fixed constant because the form of the cross-section of the water discharging over the weir for any head is similar to that for all other heads, that is,

$$\frac{b}{h} = constant,$$

while this is not true for rectangular notches. When it is observed that the flow of water over a weir is the result of the action of gravity modified by various secondary causes, such as velocity of approach, resistance of the air, temperature, adhesion of the water to the edge of the weir and other influences, it is hardly to be expected that a single constant will suffice for all the possible conditions.

That there should be two values given widely differing from each other can probably be explained by the fact that Professor Rankine, who is largely quoted as an authority, was the first to refer to Thomson's work. It was in the first edition of his "Manual of the Steam Engine," which was published in 1859, that he mentions Thomson's formula. This was before Thomson had completed his work. Rankine continued to give 2.645 as the value of the constant in at least three editions of his book, or till 1866. For lack of the intervening editions the writer has been unable to determine just when the change was made, but at least in the eighth edition published in 1875 the proper value is given. This was after Rankine's death, which occurred in 1872.

In Table 3 is given the weir discharges for heads varying from 0.05 to 1 foot computed from the formula,

$$Q = 2.544\, H^{\frac{5}{2}}.$$

Except for raising H to the power indicated the computing was done by means of the Fuller slide rule. The greatest error is probably not more than 1 in 1000; in many cases it is less than 1 in 10,000. The work has been checked over; still it is not impossible that a mistake may be found. In the computations one cubic foot of water was taken as 7.48 United States gallons, and one United States gallon equal to 8.34 pounds at 60 degrees Fahrenheit.

TABLE 3. WATER DISCHARGED THROUGH RIGHT-ANGLED WEIR NOTCH.

Head in Feet.	Discharge. Cubic Feet per Second.	Gallons per Hour.	Pounds per Hour.
0.05	0.001422	38.29	319.3
0.10	0.008047	216.67	1,806.8
0.15	0.02217	596.95	4,978
0.20	0.04551	1,225.40	10,220
0.25	0.07950	2,140.80	17,852
0.30	0.12542	3,377.00	28,164
0.35	0.18437	4,964.50	41,403
0.40	0.25745	6,930.81	57,810
0.45	0.34548	9,302.21	77,500
0.50	0.44977	12,111.00	100,980
0.55	0.57060	15,365.0	128,138
0.60	0.70927	19,098.0	159,280
0.65	0.86650	23,333.0	194,580
0.70	1.0430	28,086.0	234,220
0.75	1.2392	33,369.0	278,280
0.80	1.4562	39,210.0	327,000
0.85	1.6946	45,628.0	380,510
0.90	1.9550	52,641.0	439,000
0.95	2.2380	60,261.0	502,540
1.00	2.5440	68,502.0	571,300

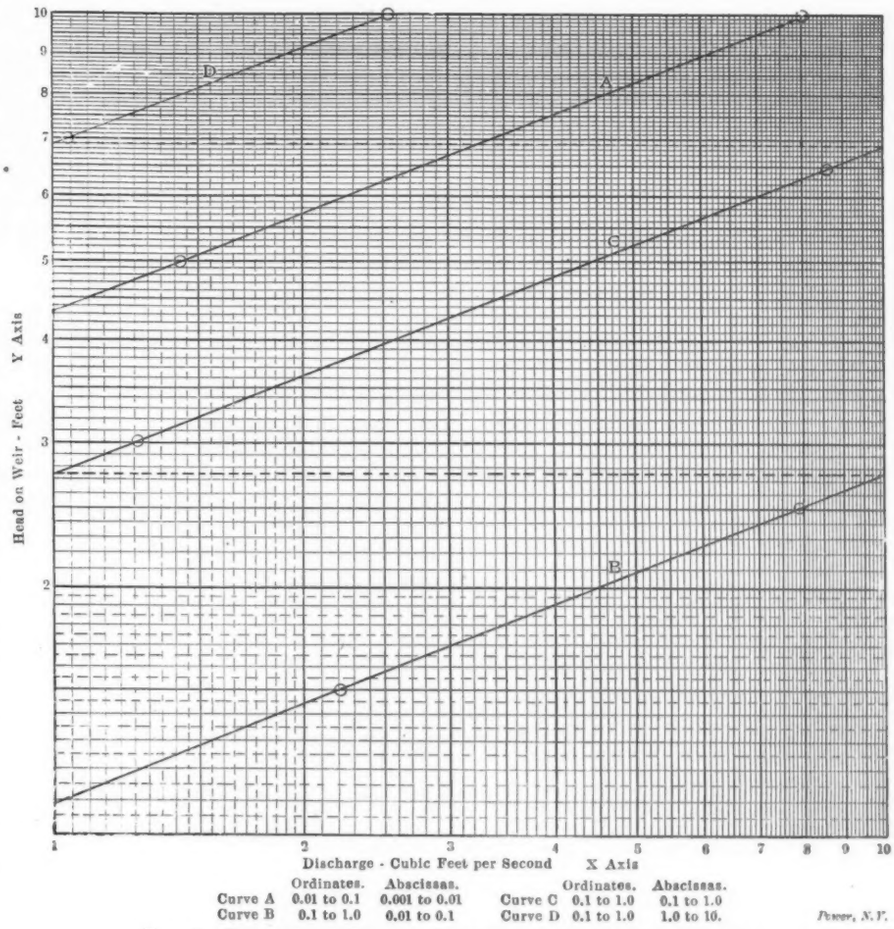

Head on Weir - Feet Y Axis
Discharge - Cubic Feet per Second X Axis
A
B
C
D
Ordinates. Abscissas.
Curve A 0.01 to 0.1 0.001 to 0.01
Curve B 0.1 to 1.0 0.01 to 0.1
Curve C 0.1 to 1.0 0.1 to 1.0
Curve D 0.1 to 1.0 1.0 to 10.
Power, N. Y.

FIG. 2. DISCHARGE CURVES PLOTTED ON LOGARITHMIC PAPER

It is often convenient and sufficiently accurate to use a curve in reducing a large number of observations. When it can be done an enormous saving in time is effected. The expression which gives the discharge of the triangular notch is an exponential equation. It can be most readily plotted on logarithmic paper, as shown in Fig. 2, as this particular paper is ruled in such a way that the distance between lines is proportional to the logarithms of the numbers which they represent; that is, the distance between 1 and 2 represents the interval between the logarithm of 1 and the logarithm of 2.

In Fig. 2 curves *B*, *C* and *D* have the same scale of ordinates but different scales of abscissas. Curve *A* has a different ordinate scale as well as different abscissa scale. By this use of different scales on the same sheet a wide range of values may be plotted. To illustrate the use of the curves, suppose the head on the weir was 0.22 foot. The scale of ordinates which will contain 0.22 must be between 0.1 and 1, so beginning at 0.22 on the vertical scale follow across the sheet horizontally to the *B* curve, then vertically down to the *X* axis. The reading there is 583, and as *B* is laid off with abscissas from 0.01 to 0.1, it will be known that the reading must be 0.0583.

A boiler needs washing at least once every month and more often if the feed water is bad. Do not allow mud or scale to accumulate in the boiler and do not allow oil or grease to enter the boiler; these foreign substances may cause overheating and burning of plates and result in a bag, rupture, or violent explosion. A solution of soda ash or a small quantity of kerosene fed continuously into the boiler is often beneficial in preventing or softening scale. If kerosene is used, great care must be exercised to see that it is entirely gotten rid of by allowing a draft to blow through the boiler before bringing a naked light to the boiler or allowing anyone to enter the boiler, as an explosion may ensue or the fumes may overcome the person entering.—The Fidelity and Casualty Company of New York.

Electrical Department

An Unlucky Induction Motor

By R. H. FENKHAUSEN

Especially conducted to be of interest and service to the men in charge of the electrical equipment.

A 20-horsepower induction motor in the plant under my charge met with so many mishaps and required such unusual repairs that it became noted as a sort of mechanical Jonah. The motor was installed in a small frame building situated on the wharf, and drove a group of machine tools used during the overhauling of a large steamer. One night the building was completely destroyed by fire and the planking of the wharf was so badly burned that the motor fell through it and went to the bottom of the bay. After the underwriters' inspection was

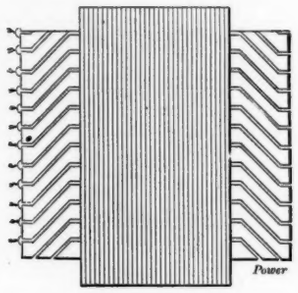


FIG. 1. CORE AND WINDING

over and some of the wreckage cleared away, a tackle was rigged up and at low tide the motor was raised from its watery bed and taken to the shops for examination and, if possible, repair, although it was thought that the sudden cooling of the machine by plunging into the water while almost red hot had warped the cast-iron frame beyond repair.

The motor was completely dismantled, and to our surprise the stator bore calipered perfectly round and true, probably due to the stiffening action of the heads, which were of course in place. The stator winding had been of the formed coil type laid in open slots, and as only bare copper remained, the winding was removed and the slots thoroughly cleansed of all rust and dirt.

As our electrical shop was unusually busy at the time, the job of making a new set of coils was given to an outside repair shop, and the stator frame was sent there with instructions that the coils be placed in the slots, but not connected up. This was done to make sure that the coils were not too thick for the slots, as trouble from this cause had been met with before.

While the coils were being made the rotor bars were reinsulated, the shaft trued up, the bearings re-babbitted, and the rotor balanced, as the lead balance weights had been melted out in the fire. The night before the motor was to be returned, the down-town repair shop burned down and the stator winding was again destroyed; but the owners of the shop secured temporary quarters, made new coils, and in due time delivered the motor frame with the coils in place.

Upon the arrival of the stator we again calipered the bore and found it to be so badly warped by the second fire that the rotor would not enter, but this had not been noticed by the repair shop. The absence of the heads during the second fire probably was responsible for the distortion, as the first fire was much worse than the second and no distortion had occurred.

After rejecting several schemes as impracticable, it was finally decided that the complete set of laminations with all the coils in place (Fig. 1) would have to be removed from the cast-iron frame.

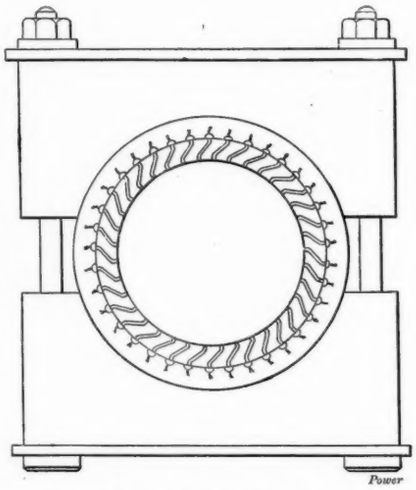


FIG. 2. CORE CLAMPS

It was considered advisable to leave the coils in place because there is always danger of damaging the insulation in taking the coils out of the slots and, moreover, it was thought that the coils would help to hold the laminations together and to keep the teeth in line.

The laminated core was driven out with a light sledge and drift, care being used not to injure the coils. A pair of holding clamps (Fig. 2) was then made and in these the laminations were pressed back into shape. The bore was calipered and found to be perfectly round and axially true; then the rotor was tried in the stator bore and the air-gap tested. The winding was tested for grounds, crossed phases and open circuits and was found to have been unharmed by the straightening process.

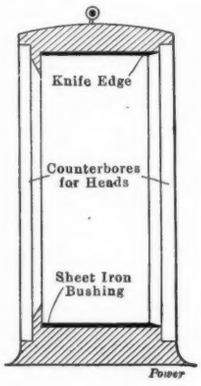


FIG. 3

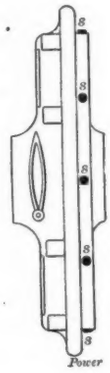


FIG. 4

The cast-iron stator housing was found to be ⅛ inch out of round, so the frame was trued up on a boring mill; both the internal counterbores for the heads and the main bore for the laminations were tooled out ⅛ of an inch larger than the original diameters, which were ascertained by measuring the laminations and the heads. A piece of 1/16-inch boiler plate was then rolled into a bushing to make up the ⅛ inch difference between the external diameter of the laminations and the bore of the frame, and this bushing strip was cut a quarter of an inch short of the length required to make a complete circle in order to provide a way for the key which held the laminations in alinement. One edge of the bushing was filed to a knife edge to facilitate the entrance of the laminations, and it was shoved into place as shown in Fig. 3. The laminations were then driven home and the key and locking ring inserted. Owing to the fact that the frame counterbores had been enlarged, the heads were of course too loose, so eight ⅜-inch studs were screwed into the heads as shown in Fig. 4, and turned off in a lathe to fit the frame.

The coils were connected up next, and as they tested clear the motor was assembled and started up. It was found,

however, that the motor would not run over 850 revolutions per minute, whereas it should have run nearly 1800, being a four-pole 60-cycle machine and unloaded. After losing some time in vain attempts to locate the trouble, the rotor was removed and a pole to pole test of magnetic polarity made with a pocket compass while the stator windings were excited with direct current from a few dry-

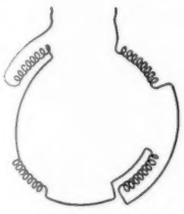


FIG. 5

FIG. 6

battery cells. This test revealed that all four poles in each phase (it was a two-phase machine) were of one polarity. The connections were gone over and found to be normal, as shown in Fig. 5. The explanation for this apparent paradox was revealed when the man who made the coils was questioned. It developed that he had wound alternate pole groups in opposite directions to shorten the connecting wires between pole groups, but had neglected to inform us of the fact. The stator winding was reconnected as shown in Fig. 6, and the motor ran perfectly.

After this unusual series of mishaps the motor changed its luck and has run without a mishap ever since.

Equalizing the Voltages of a Multipolar Generator

BY C. G. CARLSON

I have found that it is essential with some of the dynamos in my charge to get the armature electrically centered in order to prevent poor commutation, sparking at the brushes and constant blackening of the commutator. The usual way of centering an armature is to use wooden wedges, and this method, as a rule, is considered near enough to accuracy. I have found it better, however, to center the armature magnetically, although the process is longer and more tedious.

Before beginning the adjustment of the field magnet, I make a simple diagram like Fig. 1, on which to record the results of successive adjustments. The diagram here shown is for a six-pole generator; the lines represent radial center lines through the brushes of the machine, and the letters indicate the magnet poles. The armature is centered, or, more correctly, the field magnet is adjusted, to obtain equal magnetic strengths under the pole faces. The armature is driven at normal speed and the voltage of each section of the winding is measured by putting down the two sets of brushes corresponding to that section, lifting all the others off the commutator. These voltages are written on the diagram in the

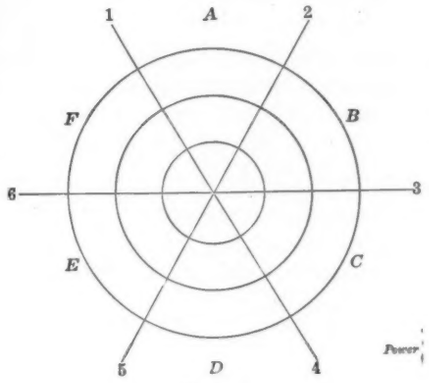


FIG. 1

spaces between radial lines corresponding to the armature sections, as in Fig. 2. The figures here shown mean that in the first test the voltage between brushes Nos. 1 and 2 was 222; between Nos. 2

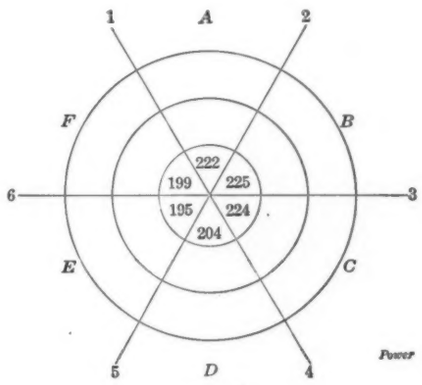


FIG. 2

and 3 it was 225; between Nos. 3 and 4, 224; between Nos. 4 and 5, 204; between Nos. 5 and 6, 195; between Nos. 6 and 1, 199. After this first test the machine

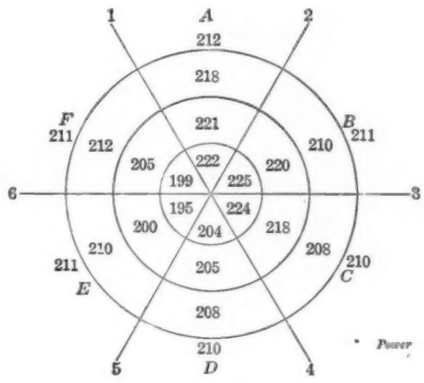


FIG. 3

was shut down and the field magnet shifted and shimmed with a view to reducing the distances between the armature core and the magnet poles *A*, *B* and *C*, and increasing the airgaps under the poles *D*, *E* and *F*. Then another test was made, with the results shown in the second circle from the center, in Fig. 3. This diagram shows the results of each test and the subsequent adjustment; four tests were made before approximately equal voltages were secured between all neighboring pairs of brush studs. It is advisable to have the upper magnet poles slightly stronger than the lower ones to relieve the bearings of part of the armature weight.

LETTERS

Three Wire and Two Wire Generators

In the August 23 issue of POWER, Mr. Smith praises the three-wire generator, but from his remarks I feel sure that he is operating under conditions most favorable to this class of machine.

The chief argument in favor of the three-wire machine is that the system is operated from a single unit which can be started and operated like a two-wire machine; this is one of the advantages which Mr. Smith points out. Another reason he gives for favoring the three-wire unit is its ability to regulate the voltage of the system for fluctuating loads, but this can also be done by a two-wire generator operated with a balancing set or by the old arrangement of two dynamos each carrying one-half of the load.

My experience with the three-wire machine is that it will not regulate the voltage on either side of the system independently to compensate for unbalanced load; that is, if the load becomes heavier on one side of the system than on the other, the increased current through the series field winding raises the voltage on both sides alike, which makes that of the light side of the system abnormally high, and this unbalancing of the voltage increases as the unbalancing of the load increases. Adjusting the shunt field rheostat will not remedy the fault, since such regulation has a like effect on both sides. For systems designed and operated so that the unbalancing is slight this type of machine is well adapted, but when the system is unbalanced due to large two-wire service connections not properly divided between the two sides of the system, or to shifting of the load from one side to the other at irregular intervals, the three-wire machine will give poor regulation.

I have used balancing sets in connection with regular two-wire generators and have found that they will automatically regulate for equal voltage on both sides with unbalanced load and retain all the advantages of simplicity of connections and operation of the straight two-wire system. One balancing set will serve

several generators, though for reliability of service it is best to have two sets. Actual tests have shown the combined efficiency of the generator and motor balancer to be higher than that of the three-wire generator and balancing coils.

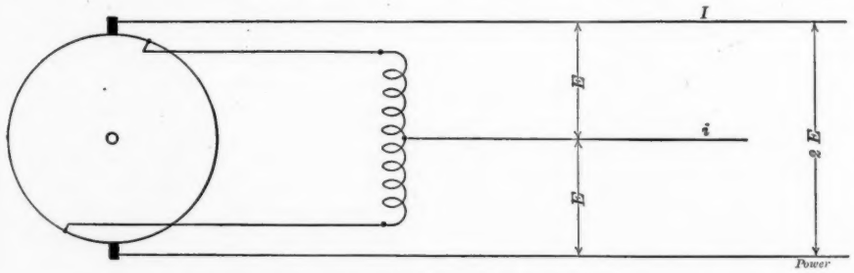
The connections of the three-wire generator are complicated, requiring two sets of series field coils, two equalizers, an extra circuit-breaker, switch and ammeter, and an extra busbar with supports. Considering the special design of the generator and the additional apparatus required, it is doubtful if the complete installation has any advantage in first cost or in maintenance.

LEWIS C. REYNOLDS.

Willard, N. Y.

The Three Wire Generator

Mr. Smith's article on the three-wire generator, in the issue of August 23, contained potent remarks on a type of machine with which many of the readers of POWER are probably more or less familiar, many no doubt having such machines under their immediate supervision. The three-wire generator combines two machines in one, resulting in higher economy of operation and of space; requires less care, lessens commutation troubles and costs less than any other equivalent equipment. The balancing coils do not necessarily require floor space and need no more attention than ordinary transformers.



ELEMENTARY CONNECTIONS OF THREE-WIRE GENERATOR

Perhaps some men operating three-wire machines have wondered why the balancing coils were so small compared with the size of the generator. Consider a machine with one coil, as represented by the accompanying diagram. If the voltage of one side of the system $= E$, giving $2E$ across the outside, the power rating of the generator equals $2EI$, I representing the current in the outside conductor. The voltage impressed on the balancing coil is alternating, and has a maximum value of $2E$, giving an effective value of 1.414 E. The neutral current divides on entering the coil; therefore, the current to consider is one-half of the neutral current, which may be expressed as $0.5i$, neglecting the small magnetizing current. The volt-ampere capacity of the coil equals $1.414E\,0.5i$, which is equivalent to $0.707Ei$. Then the ratio of the volt-ampere capacity of the coil to that of the machine would equal

$$\frac{0.707Ei}{2EI}$$

which reduces to

$$0.354\frac{i}{I}$$

Now, it is evident that if the neutral current i equaled the current I in one of the main conductors, or in other words, if only one side of the system were loaded, the coil would have but 35.4 per cent. of the generator capacity, and with two coils, as is generally the case, the capacity of each would be approximately 18 per cent. of that of the machine. As the coil is an autotransformer with a one-to-one ratio, it would have to be but one-half the size of a transformer of the same volt-ampere capacity, or 9 per cent. of the capacity of the generator.

But the neutral current, instead of being equal to the current in the outside conductor, is seldom if ever more than about 25 per cent. of it, so the coil would need to be the size of a transformer of but 2.25 per cent. of the generator capacity, which would be very small.

Three-wire generators under ordinary conditions of load regulate very closely and require no more care than the ordinary type of generator. They are paralleled as easily, no account having to be taken of the balancing coils, and for the average installation using three-wire direct-current distribution they are hard to equal for all-around satisfaction, especially to the man who has the care and the worry.

A. C. KERR.

Ft. Monroe, Va.

Unbalanced Airgaps on Induction Motors

Mr. Orr's experience with an induction motor which would not run with an unbalanced airgap but ran all right as soon as the airgap was equalized around the rotor agrees with a number of experiences I have had along the same line. A number of years ago a 5-horsepower 110-volt single-phase induction motor came in the shop as having been "burned out." It did not look very bad, so we connected it up and threw in the switch; it refused to move—just stuck and roared—and I could not move it by dragging on the pulley with both hands, although without the current it revolved freely. I took it apart but an examination showed no burned coils. We tried everything we could think of and finally one of the bearings was raised a little before the bolts were drawn down tight and the motor started off like a new machine. We had accidently found it. We shimmed up the bearings to equalize the airgap and heard no more from that "burned-out" motor. A short time ago I had a similar experience with a ½-horsepower motor driving a vacuum cleaner. This was also "burned out." I threw in the switch and it showed all the symptoms of an unsymmetrical airgap; then I raised one end of the shaft and it immediately started. A new bearing was secured and the motor has given no more trouble.

The airgap on induction motors is very small and "finicky"; much more so than on direct-current motors, and successful operation cannot be obtained with an unequal airgap. In neither of the two cases I have cited was the rotor touching at any point; it seemed to stick as if a powerful magnet were holding it at one point, and that is practically what takes place. Most manufacturers of induction motors send out an airgap gage with each of their motors; this is merely a thin strip of steel ground to the same thickness as the airgap and it should be possible to insert it at any point of the airgap; if the gap is too small at any point the bearings should be adjusted to permit the gage to enter.

I have had three different cases with 50-horsepower motors caused by melting the babbitt in a bearing and I always caution the machinist about the necessity of having the rotor revolve exactly in the center of the space and not merely to move freely.

G. S. SPRAGUE.

Geneva, Neb.

The induction-motor trouble experienced by Mr. Orr, as outlined in the issue of August 23, was probably due to the bearing having been worn away on one side to such an extent that the rotor was pulled against the stator when current was passing through the stator winding, although it did not quite scrape when the current was off.

Very often an induction motor with loose cap square bolts, especially if the motor is of small size, will refuse to run until the bolts are tightened down, due to the fact that the rotor, being somewhat above the center, is pulled against the stator by the magnetism when the stator winding is energized. Mr. Orr's trouble was probably similar.

A. C. KERR.

Ft. Monroe, Va.

Gas Power Department

An Interesting Gas Power Factory Plant

By Osborn Monnett

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men.

Gradually the gas engine is making its presence felt in the larger industrial institutions in competition with other forms of motive power and is beginning to hold its own in fields where steam was the only thing thought of a few years ago. The case under consideration is an interesting example of the encroachment of gas power upon the field of steam, and the methods employed to insure the same character of service, not only for power but for heating the buildings and supplying hot water for various purposes, are notable as indicating the probable trend of development along this line.

The manufacturing establishment for which this plant furnishes the power is that of the A. O. Smith Company, of Milwaukee, maker of automobile parts. The power plant occupies one end of a brick and steel fireproof building, the other end of which is devoted to the blacksmith shop, annealing ovens, etc., the two departments being separated by a fire wall. Electrical distribution is used exclusively. The generating unit is an Allis-Chalmers tandem double-acting gas engine, with 24x30-inch cylinders, direct connected to a 400-kilowatt direct-current Allis-Chalmers generator and running at 150 revolutions per minute. The engine, as is common practice in larger sizes, has an intermediate crosshead between the two cylinders and a tail rod supported by a crosshead at the rear, both running in bored guides resting on the foundation and designed to support the weight of the pistons and piston rods so that they may travel without imposing weight on either the walls of the cylinders or the stuffing boxes.

The inlet valves are located at the top and the outlet valves at the bottom of the cylinders, as in most double-acting engines. The frame is of the open type, which gives easy accessibility, with the slipper crosshead used in the larger engines of this make. The jaw in which the main bearing shells are held is especially heavy and rigid and the bottom bearing shell is water cooled. This part of the frame, which must receive the full thrust

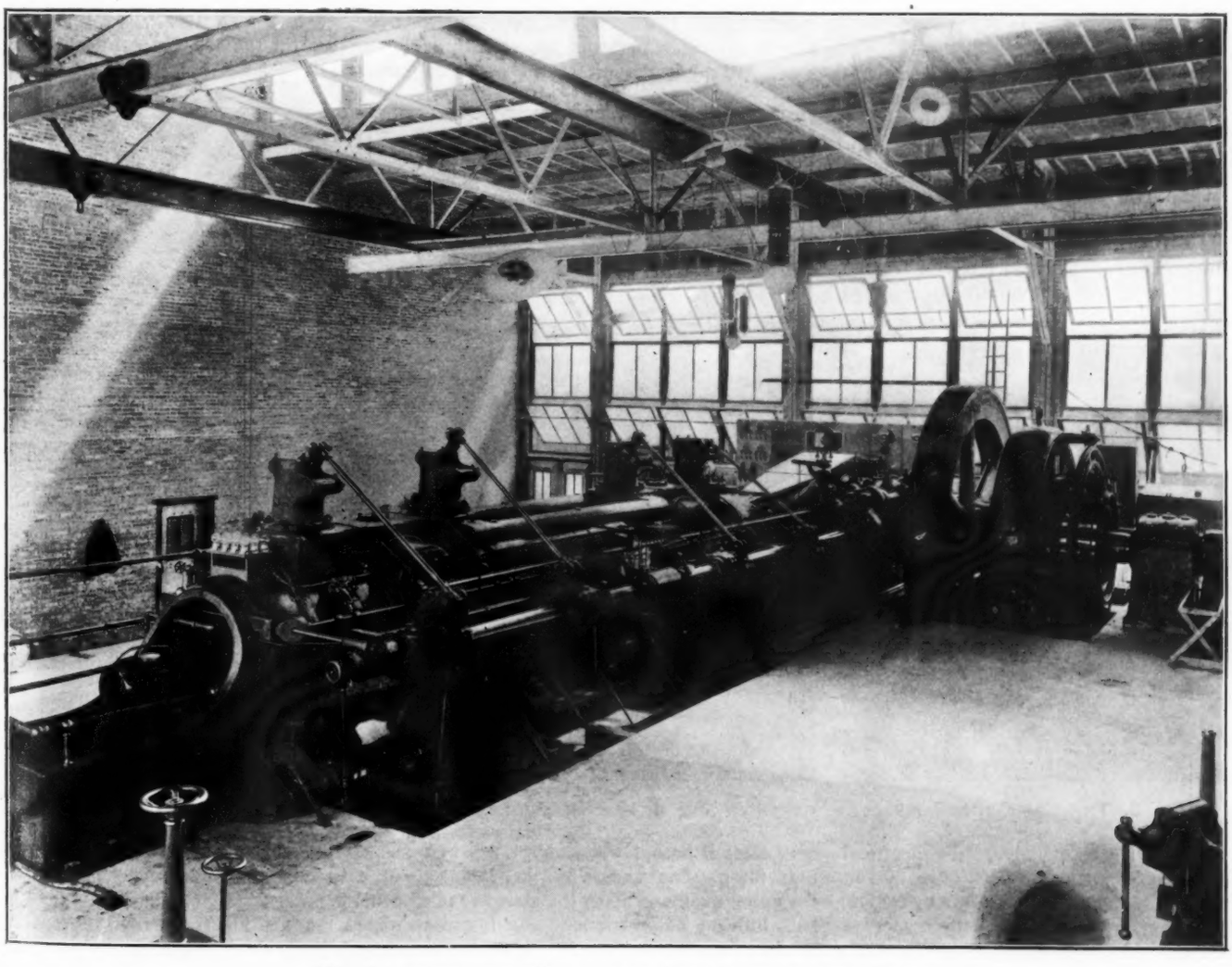


Fig. 1. Generating Unit of the A. O. Smith Factory Plant

of the explosions, is further strengthened by two steel tie bolts extending across the jaw above the bearing. A feature of the engine differing from most of the other makes is that the two cylinders and the distance piece between them are cast in one piece. The cylinder casting proper is subjected to no wear, as the working bore is fitted with a hard cast-iron liner to take the wear due to the motion of the piston.

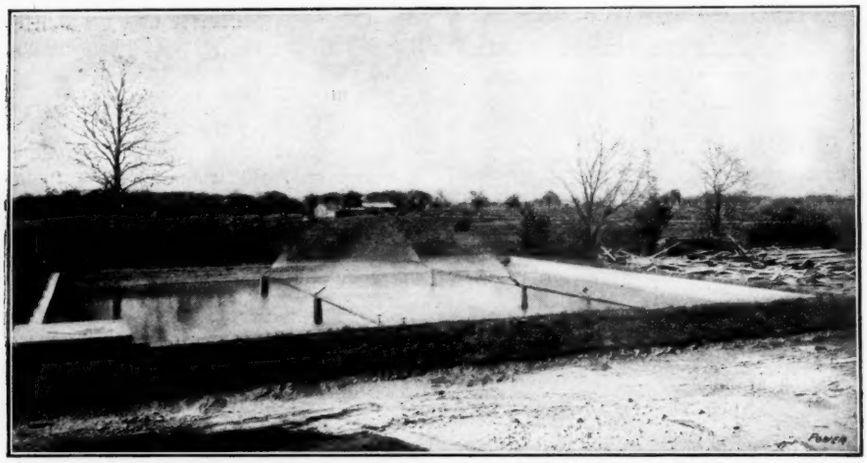


FIG. 2. COOLING POND AND SPRAYS

AUXILIARY DETAILS

"Quantity" regulation is used, the admission of mixture being controlled by a fly-ball governor driven from the valve-gear shaft. The gas and air inlet conduits are cast integrally with the cylinders and the valves themselves are of the simple poppet type, mounted in removable cages. Mechanical make-and-break ignition is used, and two igniters, located at well-separated points, are provided in each end of each cylinder. The electrical ignition equipment consists of a 30-volt dynamo mounted on the main engine, operating in conjunction with a storage battery, and a coil for each working cylinder connected in series multiple with three low-voltage lamps which can be connected or disconnected to vary the intensity of the spark.

The engine is provided with an air-starting gear which, as usual, is normally disengaged and inoperative. On opening the air throttle the air pressure automatically throws the starting valve gear into engagement with cams on the valve-gear shaft which open and close the air valves in proper time to start the engine.

Lubrication is effected by means of a gravity system, a pump on the valve-gear shaft returning the oil to an overhead tank after it has passed through a White Star filter. The excess oil handled by the pump overflows from the storage tank back into the pump suction. For internal lubrication Richardson sight-feed oil pumps are provided, the oil being introduced at two points in the cylinder and timed to give the maximum benefit.

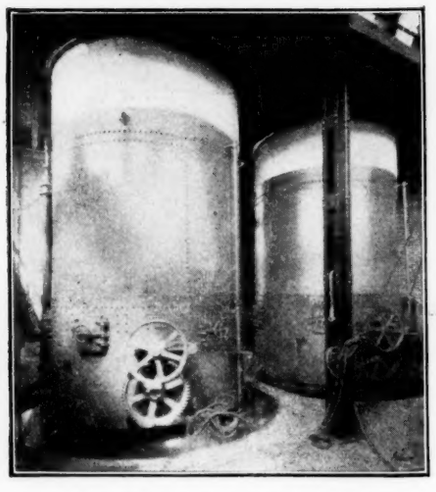


FIG. 3. THE GAS GENERATORS

COOLING ARRANGEMENTS

The cooling system has been designed with a view to minimizing the consumption of water, which must be bought from the city. A concrete cooling reservoir, approximately 50x60 feet in size and holding about 88,750 gallons of water, has been provided from which to draw the water supply from the engine. Located in the basement and belted to the main engine shaft is a geared pump which delivers water to the engine jackets as needed. The cooling water passes through the piston, exhaust-valve cages and stems separately from the cylinder jackets, and valves are provided to regulate the flow to the different parts independently. The overflows are placed in plain view of the operator and the discharge water is collected in a tank in the basement from which it flows by gravity to Koerting spray nozzles over the cooling reservoir, shown in Fig. 2.

PRODUCER EQUIPMENT

In the producer room are two 750-horsepower Wood producers, the generators of which are equipped with shaking grates through which the ashes are delivered to a water-sealed pit and with vaporizers in the top for furnishing the necessary steam. The gearing through which the grates are shaken by means of a hand crank appears in Fig. 3. A 5-horsepower motor-driven blower furnishes an air blast directly above the grates, the producers being of the pressure type. Scrubbers of the usual verti-

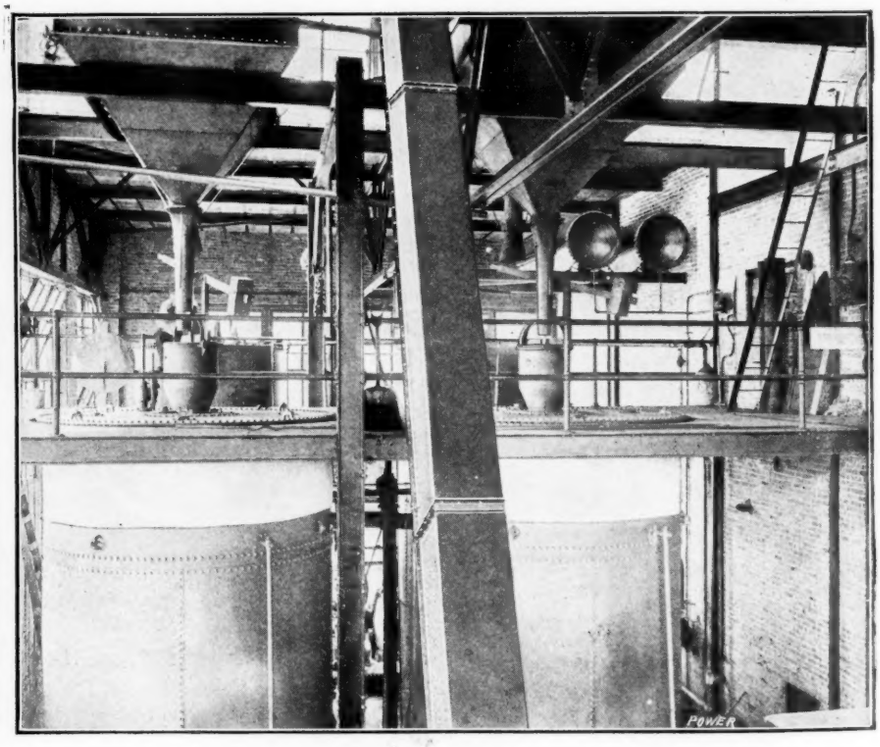


FIG. 4. PRODUCER-CHARGING PLATFORM AND COAL ELEVATOR

cal type are provided, after passing through which the gas goes to a centrifugal scrubber and tar extractor (Fig. 5) driven by a 25-horsepower motor; from this machine it is delivered to a small gas holder outside of the building, whence it is drawn by the engine as needed. Coal is unloaded from cars into a bin of 100 tons capacity, into which dips the leg of a bucket elevator operated by a 5-horsepower motor; this outfit raises the fuel to small individual hoppers over each producer (see Fig. 4).

On the operating platform of the producers (see Fig. 4) is located a gage board carrying U gages which register the gas pressure in the collecting main leading to the gas holder and the air pressure under the grate and above the fire in each producer. There is also a U gage one leg of which is connected to the air blast and the other to the steam generator, the gage indicating the excess pressure of the blast over the pressure of the steam which is generated in the vaporizer.

Several kinds of fuel have been tried in this installation, the first being coke breeze at $1.75 per ton, followed by pea size coke at $2.50 a ton. There was found to be a surprisingly large amount of tar in this fuel.

The large volume volume of coke which had to be handled was also an objection, and the fuel finally decided upon was pea anthracite, which costs $5.60 per ton delivered on the side track at the plant. It is stated that one ton of the anthracite coal has been found equal to 3½ tons of the pea coke.

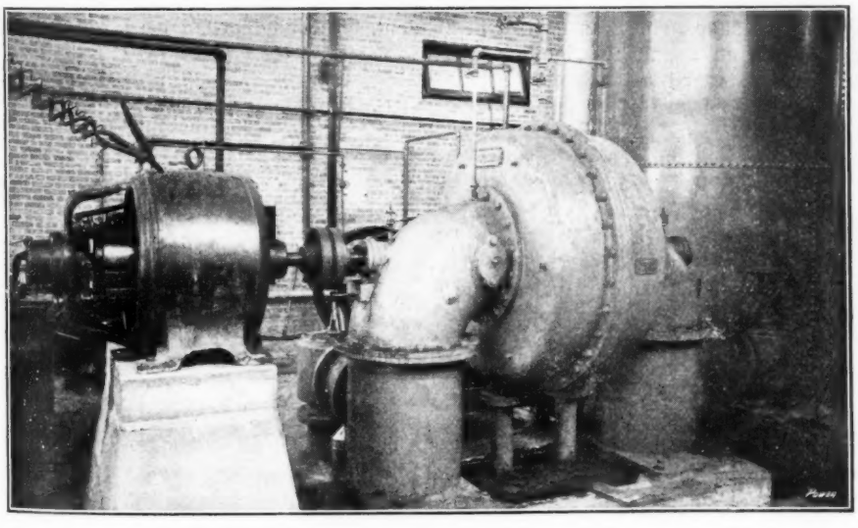


FIG. 5. MOTOR-DRIVEN TAR EXTRACTOR

WASTE HEAT UTILIZATION

One of the most interesting features of this plant is found in the arrangement for utilizing the waste heat of the exhaust gases from the engine. In the main exhaust line of the engine is inserted a "transverse current" water heater containing 334 square feet of heating surface, from which the exhaust line continues to an exhaust muffler outside the building and thence to the atmosphere. An interesting detail of this equipment is that the entire exhaust pipe, water heater, muffler, etc., which extends in a straight line from the engine foundation, rests on rollers and is free to expand or contract under the varying influence of the exhaust heat. Where the exhaust line parallels the foundation it is supported on arms projecting at an angle and resting in ball-and-socket joints embedded in the foundation.

The heater, a close view of which is shown in Fig. 6, is the Riblet apparatus which was described in the issue of April 19 in connection with some brief tests made in conjunction with a Westinghouse gas engine.

No attempt has been made to economize the heat absorbed in the water jackets but a test of a heater alone, placed in the exhaust line, has, on a smaller installation, shown a return of over 32 per cent. of the total heat supplied to the engine. It is unfortunate in this case that so far the hot water supplied by the heater has been only partially utilized, being circulated in the shop radiators and the lavatories. For the present the excess hot water is returned to the cooling pond and used over again in the engine.

HEATING PLANT

One of the carefully worked out details of this plant is the installation for heating the shop which is 285 feet wide by 1050 feet long, all under one roof without partitions. The heating is to be done with hot water, as intimated above, there being installed two Kewanee gas-fired boilers of the locomotive type, specially designed for this plant. In each side of the firebox is a circular flue, one of which is to receive the hot waste gases from the annealing ovens in the adjoining part of the building and the other to receive the exhaust of the gas engine after it has passed through the hot-water heater. Some objection has been urged against this utilization of the gas-engine exhaust on the ground that the sulphur contained might have a deleterious effect on the boilers. However, it must be remembered that this waste gas will, in the firebox, come in direct contact with the hot waste gases from the annealing ovens and possibly a banked coal fire on the grates, which will aid in preventing the condensation of any sulphurous gases on the heating surface and flues of the boilers. As far as the heater in the exhaust line is concerned, there are only two water joints to be made and if these are kept tight it is improbable that sulphuric action will occur in this piece of apparatus, inasmuch as the entire structure is of cast iron.

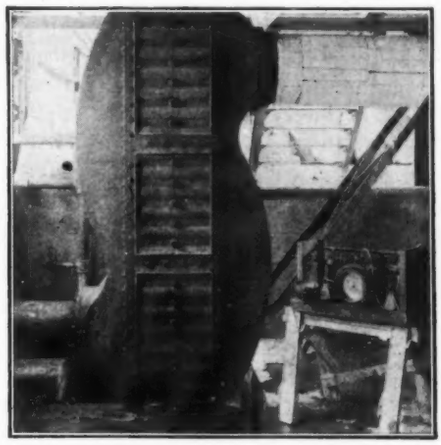


FIG. 6. WATER HEATER

Working these possible combinations it is expected that a large amount of the factory heat will be supplied this winter without appreciable extra fuel expense, which will materially increase the overall economy of the installation. The Coogan hot-water heating system has been installed in the shop. This consists of the necessary equipment of radiators through which the hot water is circulated by a motor-driven rotary pump. The temperature is automatically controlled by thermostats.

The arrangement for using the feed-water heater in series with the boilers in cold weather and taking advantage of the waste gases of both the engine and the annealing ovens was worked out by Jesse C. Coogan, of Milwaukee, who installed the heating system. It is conservatively figured that the waste heat available will be ample to heat the factory satisfactorily during at least four months of the total heating season of eight months.

SOME OFFICIAL FIGURES

This plant was put in under keen competition from steam-plant manufacturers because of the belief that its economy

over steam would justify its installation. It has been operating ten hours per day for five months and according to numerous running tests one kilowatt-hour is being produced for one pound of pea-size anthracite coal containing 11,500 B.t.u. per pound. The total cost of the producer and gas-engine installation was $50,000 as against a proposed noncondensing steam installation costing $25,000 for 750 horsepower rated capacity of boilers and engines. On this steam plant the builders would not guarantee less than three pounds of coal per horsepower-hour running noncondensing and exhausting to the atmosphere. The hot-water heating system, consisting of the two locomotive-type boilers and 40,000 square feet of direct coil radiation, was installed at a cost of $19,000, which carries the cost of the entire installation up to $69,000. If the noncondensing steam plant had been installed it was estimated that a vacuum steam-heating system would have cost $30,000, making the total steam installation cost $55,000, or $14,000 less than the present plant investment.

The power plant is now consuming 2100 pounds of coal for ten hours' work which, at $5.60 a ton, amounts to approximately $5.90 per day, or a total of less than $1950 per annum for fuel. Adding to this the estimated consumption by the heating system, during the coldest months of the year, of 900 tons of steam coal at $3 a ton, makes a total fuel cost for heating and power of $4650. These figures show a saving of over 60 per cent. per annum in fuel over the estimated performance of a steam plant. Moreover, it was figured that if a condensing plant had been installed to realize better steam economy, the additional cost of a cooling tower, which would have been necessary because the water is bought from the city, would have materially increased the investment charges for the latter type of plant.

Some Reminiscences of Early Days

By A. E. Walker

A number of years ago, when trying to start an engine that had been just installed, I had a very narrow escape from being knocked out by it. The lay shaft for driving the valve gear had not been properly marked by the makers and we got it in gear wrongly with the main shaft, with the result that when we started up, the engine tried to run backward.

We shut off the gas supply to the cylinder, leaving the ignition-tube burner alight to save time in starting again and pulled the wheels round two or three times to make sure that no gas remained in the cylinder. To adjust the lay shaft, we had to jack up the main shaft until the gears cleared, and we had just done this, and I was kneeling on the floor in front of the engine turning the lay shaft round, when suddenly there was an explosion in the cylinder and the shaft and flywheels came rolling forward (it was a single-cylinder horizontal engine).

What saved me from being run over by one of the ½-ton flywheels was the fact that the shaft wasn't packed up high enough to clear the studs on the main bearings, which all got badly bent; the only other damage was a broken crank-pin oil wiper. The only explanation I could think of was that the gas-stop valve leaked, so we took the plug out and reground it, but I never worked on a gas engine again with the ignition tube hot.

One night the man in charge of an engine and dynamo for lighting a jeweler's shop came round and asked us to send someone at once to see what had gone wrong with his engine, as the cellar was full of smoke though the engine was still going. When I got to the shop the smoke was pouring up through a ventilator under the window and driving people off the sidewalk. Upon investigation I found that the floor had been cut out to clear the flywheel, and the hole had been allowed to fill up with waste-bearing oil; when the engine was started the wheel threw this oil over the hot exhaust-valve box.

At one small repair shop where I worked once we had a 2-horsepower gas engine solely for driving a dynamo for lighting the shop. This was located in a cellar, and as usual, the ignition-tube burner was tapped off a separate pipe not in connection with the supply to the engine cylinder, the idea being to avoid fluctuations. This burner happened to be supplied from the same pipe as a few gas jets we had in the shop and thereby hangs a tale.

One day, the boss had gone out, and the apprentice who usually looked after the engine and dynamo had gone below to start up, as it was getting dark. Some bright specimen of humanity upstairs suggested waiting until he got the engine started and then blowing down the gas pipe and putting the ignition-tube burner out. Everyone fell in with the scheme and we soon had a man at each gas bracket.

By and by the electric lamps began to glow and then at a given signal every man put his mouth over a gas burner, opened the tap and blew for all he was worth. Two or three spare men listened for the fun on the stairway. It was a short pipe and a few moments of blowing put the burner out; after a few big bangs, backfires and misses, the engine shut down. After relieving his feelings the apprentice lighted the burner again and when the tube got hot, put the starting handle on again and turned her over while the wind-bag brigade upstairs got ready to send another cyclone down.

The trick was repeated several times and when the apprentice had given the engine up in disgust, the old man came down and wanted to know what was wrong. The boy told him he could not get the burner to keep alight, and the boss suggested trying again, and of course it went all right to the boy's utter amazement, and he never found out why that engine did stunts.

CORRESPONDENCE

Setting Small Gas Engines

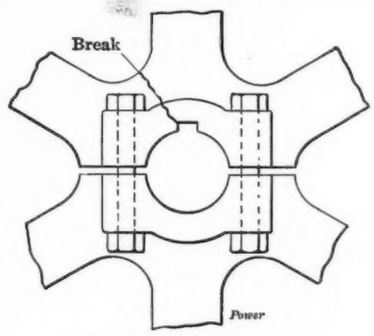
I read with much interest Mr. Wilson's description, in the issue of September 13, of his method of setting gas engines. The theory is all right, but I should like very much to know what parts of the engine the jacks are under when it is let down on the soft surface grouting, and how the base is kept truly level and the shaft in line with the driven shaft while the cement is setting. The process strikes me as a marvelous acrobatic stunt if the engine weighs more than a few hundred pounds.

Geo. W. Malcolm.

Brooklyn, N. Y.

Flywheels Broken by Preignition

A few months ago a 15-horsepower, single-cylinder, center-crank engine with two flywheels met with a peculiar accident. The engine had been running on



The Cracked Hub

a heavy load for some hours when it was found necessary to shut down for a few minutes on account of some trouble in the factory. Before the engine had come up to speed, after starting again, an explosion occurred on the compression stroke which brought it to a standstill. Another start was made but the engine pounded so badly that it was shut down. Upon examination it was found that the hubs of both wheels were cracked from one corner of the keyway through the hub, as shown in the sketch. Both hubs were broken in almost exactly the same place.

Frank E. Booth.

Toronto, Can.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words, wanted.

Self Ignition of Coal

Probably all engineers have had trouble at one time or another with self-ignition of the coal pile, and many will be able to call to mind occasions when this has been the cause of considerable expense and loss through the deterioration of the coal. The heat generated is at times very great and sufficient to give rise to serious fire risk. I came across one case in which the steel plates covering the bunker floor were warped and twisted completely out of shape. Generally speaking, self-ignition arises from improper methods of storing and failure to appreciate one or two fundamental principles. The root of the whole matter lies in the oxidization of the coal which is set up by moisture or heat or the two combined. It is slow but cumulative in effect, since the warmer the coal gets the more it oxidizes, and given the favorable conditions which so often obtain in warm boiler rooms, ignition is only a question of time once the heating has begun.

To prevent trouble from this source it is only necessary to take one or two simple precautions. If the coal is delivered wet it should not be heaped if this can possibly be avoided, but should be spread over a large area to dry and heaped afterward. This means extra expense, but is better than a fire or deterioration in calorific value. Coal should not be stored in a warm place and it should never be heaped more than 12 feet deep. The bunkers should be of iron or concrete, and should not be placed, as is sometimes the case, near to flues or boilers. If the heap is exposed to the weather the floor should be of concrete or steel with a decided slope so as to allow water to drain off rapidly. The chief precaution to take, however, is to arrange for efficient ventilation of the heart of the pile by means of spaces around the sides and at the bottom. This is seldom done, and when attempted the means taken are often quite inadequate. For instance, it is of no use to place air tubes in the heap unless they are sufficiently large to allow enough air to pass to carry off the heat generated. Otherwise, they simply assist oxidization by conveying air to the center of the pile. Such passages should be large and arranged according to a proper system of ventilation which will cause a constant current of air to flow. Wicker tubes have been employed with success, the coal being heaped around them after they are placed in position.

Bituminous and semi-bituminous coals are most liable to overheat. The more water, sulphur and volatile matter they contain the greater is the risk. A proportion of water exceeding 4.75 per cent. is sure to result in trouble unless precautions are taken, and if at any time the temperature of the center of the pile reaches 140 degrees Fahrenheit, ignition may be anticipated. To be on the safe side it is necessary to watch the temperature of a coal pile carefully. Perhaps the best means of doing this is to keep a few iron bars embedded in the heap right down to its core. It is only necessary to withdraw one of these and to attach a thermometer to it at the lower end by a handful of waste to ascertain the temperature of the pile. Experienced men can tell by touch whether the temperature is dangerous. It is better, however, to use a thermometer than to rely upon such rough and ready means.

If proper precautions have not been taken and the pile ignites, practically the only thing to do is to turn it over thoroughly, and when the heart is reached to pour water over it. It is useless to deluge the heap with water without first turning over, as probably only sufficient will penetrate to the core to make matters worse. If for any reason the pile cannot be turned over an effective alternative is to drive a good-sized pipe having holes at its lower end into the center right through the layer of coked fuel which surrounds the fire. A powerful stream of water should then be turned on. It is, of course, necessary to watch the heap very carefully after this treatment, as its damp state will be conducive to another outbreak.

FRANCIS H. DAVIES.

London, England.

Trouble with a Pumping System

Our pipe line was originally installed as shown in Fig. 1, the pump drawing water from the river through about 900 feet of 8-inch cast-iron pipe. We were unable to make the pump hold the water; it pumped all right for a few hours and then lost water and we were obliged to prime it. We finally changed the location of the pump to that shown in Fig. 2, and experienced no more trouble of this kind, although it would not furnish as much water to the tank as formerly.

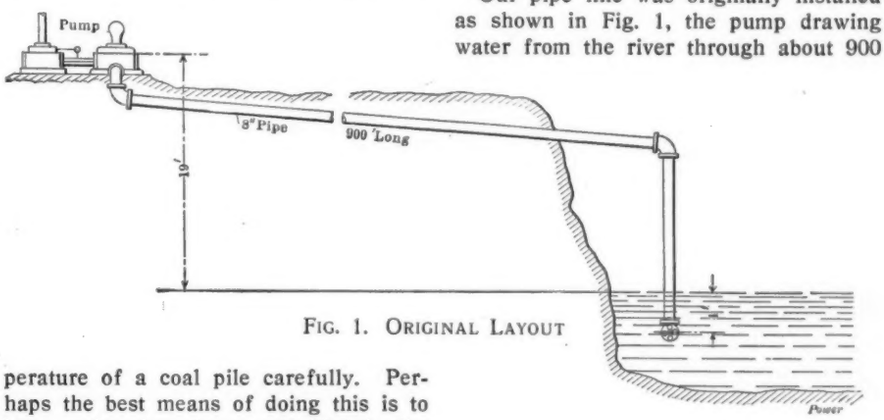


FIG. 1. ORIGINAL LAYOUT

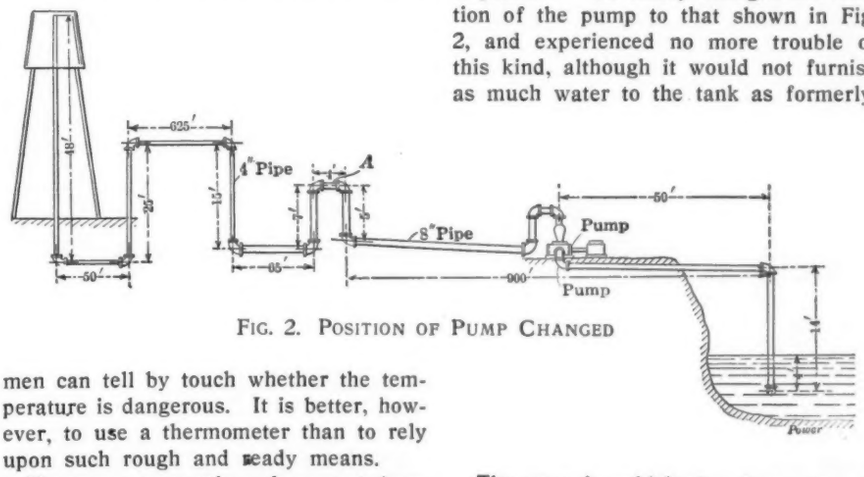


FIG. 2. POSITION OF PUMP CHANGED

The way in which the foot valve is incased is shown in Fig. 3. The rip-rap extends out into the river for about 50

feet at the end of which is placed a box made of 3-inch plank, having a steel strainer on the side opposite to the direction of the current.

Some of the attendants claim that the trouble was due to the hight of the suction and the length of the suction pipe. I do not agree with them. I claim that if the pump had been in good condition and the pipe line and foot valve all right,

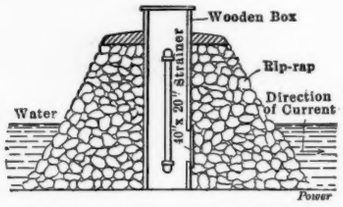


FIG. 3. FOOT VALVE CASING

the pump would have handled the water. Will some reader of POWER kindly solve the problem?

V. T. KROPIDLOWSKI.

Winona, Minn.

Installing Valves

When installing globe, angle or gate valves or plug cocks trouble is often caused by the workmen placing the wrench on the hexagonal flange farthest from the pipe while screwing the valve onto the pipe. This springs the seat and will often distort the valve sufficiently to cause a leak. The wrench should be placed as shown in the accompanying sketch. At the opposite side of the valve is shown a nipple; when the fitting is to be screwed up on the nipple the wrench should be placed on that side of the valve to support it against the pressure.

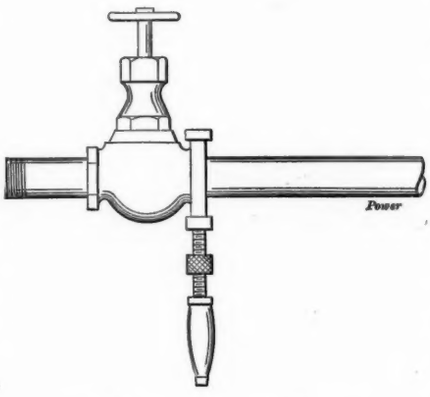
Many cases have come under my personal observation where the steamfitter has instructed his helper to place a pair of pipe tongs on the pipe at the other side of the valve while he screwed on a fitting. When the valve began to turn, the helper moved the tongs onto the hexagonal flange of the valve, marking it badly and leaving an unsightly trade mark of the man's carelessness.

It is good practice to leave a valve closed while screwing it onto a pipe. The plug should never be removed from a cock when screwing it on. Care should be taken to have the hangers as near as possible to valves on pipe lines, for it is poor practice to allow the weight of a pipe line to be carried by the valves; many leaky valves can be traced to this oversight.

I remember once watching a steamfitter who had a pot of red lead and a brush and was very careful to give the inside of every fitting a liberal coating of the paint. As I was to be in charge of the plant, I requested him to place the red lead on the outside of the pipe threads, explaining that some of the red lead, as he was using it, would probably catch on valve seats and then grit or scale would be collected at the oily point and probably cause a leaky valve. He took my request in good part and did as I advised, but I am sure the majority of careless pipefitters would have been too pig headed to take advice from a stationary engineer; for most steamfitters have a very poor opinion of the average engineer.

A steam valve should be closed tightly, for it contracts when it cools and a small amount of water passing through a valve will wear out the disk or seat much faster than a full stream. The reason for this is that a small leak will wear the disk and seat unevenly.

When a valve is closed and it continues to leak, do not use a wrench or



VALVE SUPPORTED BY WRENCH

extra force to close it. Probably there is a piece of scale under the disk. Open the valve quickly and allow a quick rush of steam through it; this often proves effective in removing anything which may have become jammed between the disk and the seat.

I have seen valves spoiled by men carelessly screwing down the bonnet when the spindle was too far down. A valve should always be open when removing or putting on a bonnet. Another source of trouble is from cutting the pipe threads too long. When the valve is screwed on, the end of the pipe is forced against the seat and the latter is often sprung.

JAMES E. NOBLE.

Toronto, Canada.

Aid in Cutting Pipe Threads

The following is so simple a trick that doubtless it is a chestnut to many; however, it costs me nothing to relate it and the information may prove of value to some.

Recently I had occasion to cut a couple of 1¼-inch pipe threads with the old-style solid die. The only dies of this size that were at hand were so badly worn that no amount of persuasion would induce either of them to start a thread. I used a little kerosene instead of oil, in starting, and the old die took hold without extra effort, cutting a nice, clean thread. Perhaps turpentine would have answered as well, but kerosene is more generally at hand and works as well as can be desired.

G. M. JOHNSON.

Escanaba, Mich.

Pump Troubles

Pump troubles are numerous and about as varied as they are numerous. In a plant equipped with two single Blake feed pumps, I had considerable trouble with one. I did not have as much trouble to make it run as I did to find out just what was wrong with it. It would hang during the head-end part of the stroke whenever it was slowed down to one-quarter speed. It would run a few strokes at the desired speed and then stop at the head end. These pumps were new and I could see no good reason for a failure to operate. Thinking that the trouble lay in the valve setting, I changed the position of the tappets on the valve stem, shortening the stroke on that end. The trouble still continued. Having moved the tappet to the end of the thread on the valve stem until the piston struck the head of the cylinder on the opposite end, I moved the tappet on the other end of the valve rod and shortened the stroke from its greatest to its shortest length, thus making the stroke first uneven at one end and then at the other. As I observed no improvement, I concluded that the trouble was due to the finish of the castings. When I removed the steam chest, the trouble was plainly visible. On the outside edge of one of the ports a V-shaped piece had been broken out. The break was about 3/16 of an inch long and ¼ of an inch wide at the edge of the port. This allowed the admission of steam to the cylinder after the valve had traveled the required distance to close the port. The steam thus admitted, overcoming the compression at the opposite end of the stroke, caused the piston to strike the head at that end. The metal was so thin and soft that it was not advisable to attempt to set in an edge piece or even put in a flush-headed screw.

There were signs of other troubles, and during the experiments the pump stopped dead at the beginning of the stroke. It could not be moved with a bar. Taking off the head of the steam cylinder I found the counterbore to be short enough to prevent the metal packing rings from getting caught in it. I then took off the cylinder head of the water end and removed the follower plate. I found that the packing had become worn and loose and two rings had dropped into the

counterbore, which was too long, and held the piston tight.

The pump had been partially spoiled by a careless machinist. It had been used for a number of months without the engineer or purchaser discovering its defects. During that time it had been paid for. As it would run at full or half speed it was hardly likely that the manufacturers would replace it, so the superintendent told me to do what I could to make it work better.

I shortened the stroke on this end and put a 3/16-inch leather washer ahead of the tappet and a ⅛-inch leather washer on the opposite end. In this way the tappets were in a position which allowed the longest possible stroke without causing the pump to stop. Should the leather washers get worn or accidentally come off, the pump would stop without the water piston overriding the counterbore, the counterbore being at the same end of the stroke as the defective port. To stop the thump of the piston against the cylinder head I had to partly close the exhaust valve. In other words, I operated the pump under heavy back pressure by regulating the speed by the valve on the exhaust pipe instead of the throttle valve. The pump is still running in this manner although the loss in economy would have more than paid the cost of counterboring and rebushing the water cylinder as well as the cost of a new port seat for the steam cylinder.

The leather washers could be removed while the pump was running and thicker or thinner ones put on to suit the speed required and quantity of water delivered.

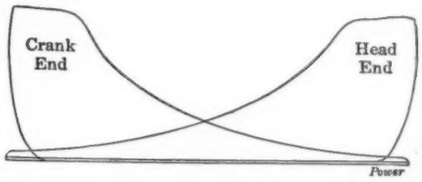
One other trouble I experienced with the pumps in this plant. One day one of them slowed up suddenly, coming almost to a stop but reversing at each end of the stroke sharply and evenly. After working over the pump for a few minutes I noticed as I tried all valves along the discharge pipe that the water level was rapidly falling in the gage glass on the boilers, which were of the water-tube type. The air cock on the discharge chamber showed that there was much pressure in the discharge line. At this point my thought turned to the check valve. The water in the boilers being at the lowest level and not having any other way of supplying them, we were forced to shut down long enough to remove the check valve. We found that it had lost the nut which held it into the hinge and had come out, turned over and wedged tight against the end of the pipe, shutting off the water almost completely. There being a combination stop and check valve and a stop valve on the line, we were able to repair the defective check without draining the boiler. The plant was running again in less than 30 minutes.

R. A. CULTRA.

Boston, Mass.

Diagrams for Criticism

The accompanying diagrams were taken from a 14x42-inch Corliss which has been in service for 37 years and has never been rebored. It is evident that



the work is pretty evenly divided between the crank and head ends. I should like the opinions of some brother engineers regarding the diagrams.

HARRY C. LEAVITT.

Lynn, Mass.

Insulating Flanges

The question of insulating flange unions on steam lines has arisen in a large plant recently. From the viewpoint of the firm and of the engineer in charge, it seems of doubtful economy.

In the first place, the cost of the labor and material required to do the work is equivalent to at least one-half of that required for all of the straight work. The work is often done before the joints have been thoroughly tested. With covered flanges bad leaks often grow from very small ones that might have been stopped at the start by drawing up on the bolts had they been accessible. When it becomes necessary to open a joint and put in a new gasket, the nuts are usually so rusted and the threads so corroded that many bolts have to be broken off before they can be removed.

I am of the opinion that a much more satisfactory joint can be made by simply tapering the pipe covering down to the base of the flange. Thus, the joint can be watched and kept right. The flanges may be coated with a water-color paint which will harmonize in color with the rest of the piping or a different color may be used, as preferred.

EDWARD T. BINNS.

Philadelphia, Penn.

A Cracked Cylinder

We have a 14x42-inch Corliss engine which has been running for nine years without giving any trouble. A short time ago, when starting up in the morning, I noticed water dripping from underneath the cylinder; but later in the day it seemed to almost stop and dripped only occasionally. At first I thought the packing in the bonnets or the flanges around the valves leaked, as I could not see them on account of the covering.

I removed the covering and found the felt packing to be soaked with water and useless. Looking further, I discovered a circumferential crack at the head end of the cylinder, starting from a point at the lower left-hand corner near the exhaust port, and extending up 7 inches on one side. I was unable to determine how far it extended on the other side on account of the valve gear cutting off my view. When I notified my employer, he said, "I suppose that means a new cylinder," and told me to closely observe the crack.

Now, the question which confronts me is: What is the best way to remedy the trouble? Can it be remedied without getting a new cylinder? Also, is it safe to keep on running with the cracked cylinder? The pressure used in the cylinder is 75 pounds.

C. G. HARRISON.

Chicago, Ill.

Ice Machine "Mystery"

The ice machine in a brewery was shut down by the day engineer at 7 p.m. on account of a boiler that had to be repaired, and as they brewed that night, it could not be started up (not having power enough for both kettle and machine) until the beer had been brewed. The night engineer let the water run over the condenser before he went home at 7 a.m. The day man tried to start the machine at 8:30 a.m. but could not do anything with it. The beer cooler would not freeze (that was the only part of the system in which the ammonia was turned on at the time). He had about 180 pounds condenser pressure in the high-pressure and about 60 pounds in the low-pressure cylinder.

A smaller machine was started, which answered the requirements. After the beer cooling, the big machine was started again to work on the cellars. It acted as fine as ever. What was wrong with the machine? My opinion is that the engineer allowed the steam pressure to get low and turned on too much ammonia so that the machine could not handle it all. The engineer still declares that the suction and discharge both were cool.

WILLIAM L. KEIL.

Philadelphia, Penn.

Provide a V-shaped brick pier or asbestos cover to protect the blowoff pipe from direct flame in the furnace. Have this pipe extra heavy with malleable elbow. Once or twice a day blow down about 2 inches of water. The best times to use the blowoff are the first thing in the morning and directly after the noon hour, on each occasion before starting up; the circulation has then been retarded for some time and the scale-forming matter has had opportunity to settle near the blowoff. Open and close the blowoff cock slowly to avoid water hammer.

Keep the boiler dry on the outside, as moisture will cause external corrosion.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues.

Economical Fire Room Methods

In the article on the fire-room methods at the Wood worsted mill, in August 2 POWER, there are a few things that I do not understand. The first one is the statements of the gas analyses. For instance, on page 1370, it is stated that the CO_2 in one gas sample equaled 15.4 per cent., but on page 1374, where the results of tests of 12 hours' duration are recorded, in only one instance is the CO_2 as high as 10 per cent. Why is there such a difference? If those "automatic" stokers could produce such a good sample of gas for the chemist, why could they not do as well during the 12-hour test?

The temperature of the gases leaving the economizer also looks too good to be true. Of course, we must remember that induced draft is used and the temperature is taken on the cool side of the economizer. If Mr. Diman's economizer is as leaky as some of them are, then 237 degrees may be all right. But it is hardly fair to ask us to believe that 237 degrees is the temperature of the waste gases. It might easily be the temperature of the waste gases plus a lot of cold air that has leaked in. It would be absurd to try to figure the chimney losses from the temperature of the chimney gases. Mr. Diman seems to be pleased with the result, for he asks how we are going to beat it. My way to beat it would be to use forced draft and thus reduce the cold-air leakage. The results might not look as well on paper as far as the waste-gas temperature is concerned, but I believe that the coal dealers might raise a kick.

Even the temperature of the gases leaving the boiler looks too good. Take, for instance, the test in which a 200-horsepower boiler is developing 316 horsepower, the temperature of the gases leaving the boiler is 491 degrees; the steam pressure is 150 pounds; the steam temperature is 365.88 degrees; the excess air is 96 per cent. and the depth of the fire is 14 inches. There is no doubt that the 20-foot tube is a good thing, but to work a boiler at 58 per cent. over its rating and get a waste-gas temperature of only 491 degrees—well, I wish that I could do it.

I believe that Mr. Diman is right about pressure regulators. If the right kind of stokers are on the job and the right number of boilers are used, a pressure regulator is not necessary. A few years ago, after reading the stories of economy effected by the use of regulators, I got a good one but could not get any more pounds of steam per pound of coal and, as the engine did not require that the steam pressure be kept up to the limit, it was discarded.

R. MCLAREN.

Berlin, Ont.

Condensing and Noncondensing

In the August 2 issue on the page headed "Inquiries of General Interest" the following question and answer were given:

"Should the valves of a Corliss engine be set differently when running condensing from what they would be for running noncondensing?"

The answer given is,

"No, the valve setting should be the same for both conditions."

My opinion does not agree with this answer. It has always been my policy to use more compression in a condensing than in a noncondensing engine. That is, I adjust the valve gear so as to close the exhaust valves earlier than for noncondensing service, thus getting a larger compression curve in the diagram, though the maximum pressure produced by compression may not be as high as that produced by the later valve closing used in a noncondensing cylinder. There is no difference in the valve operation except the earlier closing of the exhaust valves. This may necessitate advancing the eccentric on the shaft; this will shorten the point of cutoff slightly if the valve gear is of the single-eccentric type. But if the valve gear is of the double-eccentric type, any changes made to the exhaust eccentric will have no effect upon the point of cutoff.

Some years ago I was shown a set of diagrams taken from a "Jerome-Wheelock" engine. They were excellent diagrams, but I remarked on the high compression. The man who took them was from the shop where the engine was built. His reply was that it was considered good practice to carry a higher compression in a condensing engine than in a noncondensing engine. I gave the point some thought and have followed this plan ever since and believe it to be correct.

HARRY W. BENTON.

Cleveland, O.

Oil versus Coal

On page 1394 of the August 2 issue, the statement appears, "that figures are current in California that the same amount of heat can be obtained from 2½ barrels of oil as from one ton of coal," but no figures are given to substantiate the assertion. While California oil is a very satisfactory and efficient fuel, I do not know of any such figures being current in California; in fact, it would be a very poor grade of coal of which 2000 pounds would be equivalent to only 2½ barrels of fuel oil in heating value.

California oils range in density from 10 to 35 degrees Baumé. The heating value ranges from about 17,500 to 19,000 B.t.u. per pound. The density has no relation to the heating value. I have a copy of some Bomb calorimeter tests, showing an oil of 11 degrees density as having a heating value of 18,257 B.t.u. per pound, one of 17½ degrees density having 17,805 B.t.u. per pound and one of 18½ degrees density having 18,410 B.t.u. per pound.

The heavier oils are generally used for road oiling and the lighter oils for gas making and refining. What is generally known as fuel oil runs from 13 to 18 degrees in density. Oil of 16 degrees density, containing about 18,000 B.t.u. per pound is usually considered standard and weighs about 8 pounds to the gallon, or 336 pounds to the barrel; and at 18,000 B.t.u. per pound would contain 6,048,000 B.t.u. per barrel.

Kent states that Youghiogheny coal, which is a standard grade of bituminous coal in the middle West, contains 12,941 B.t.u. per pound, which would be equal to 25,882,000 B.t.u. per ton of 2000 pounds; at which rate it would require about 4.28 barrels of oil to be equivalent to one ton of coal. Comparing Kansas coal, containing 10,506 B.t.u. per pound, with an oil containing 17,800 B.t.u. per pound, it would require 3½ barrels of oil to produce the same number of heat units as one ton of coal.

In burning oil it is considered very good work, if the steam used for atomizing the fuel does not exceed 3½ per cent. of the steam heated by the oil, to say nothing of the amount that is generally used for operating the fuel-oil pumps. This, of course, should be allowed for when the commercial amount of the heat obtained from the oil is considered. In

practice the actual evaporation of 13 pounds of water per pound of oil under ordinary running conditions is exceedingly good, and somewhat better than the average, and about on a par with the tests cited on page 1374 of the same issue, which give the average evaporation of 8.89 pounds of water per pound of coal. Comparing this with an actual evaporation of 13 pounds per pound of oil, it would still require 4.07 barrels of oil to equal one ton of coal.

On page 1393 of the same issue, under the title of "Oil Fuel in the British Navy," the statement appears that 10 tons of oil were equal to 13 tons of the best Welsh coal. I presume this refers to the long ton of 2240 pounds, which, compared to California oil of the same weight and heat value as just mentioned, would require 5⅛ barrels of California oil containing 18,000 B.t.u. to equal one long ton of coal, or 4.57 barrels to equal one ton of 2000 pounds.

There is no coal burned in this section for generating steam, and it is difficult to give any exact figures as to comparative results, but in making comparisons, the heating value of both the coal and oil should be given. In a rough way, however, it is generally considered that approximately 4 barrels of oil are equal to one ton of coal. Oil has many advantages as fuel, which must be considered separately from the heating value.

G. A. REIGHARD.

Los Angeles, Cal.

Reading the Technical Paper

The editorial in the August 2 issue of POWER is opportune; it is appropriate for the experienced engineer and the layman; for the student, for the apprentice, for the engineer, for the chief and for the proprietor, the tenet "Read your scientific paper in a scientific manner" should be stored in the mine of memory. The rule is applicable to any branch of engineering and is the corner stone in perfecting a broad knowledge along such lines.

Apropos of this doctrine should be the disposition to compile one's own handbook, to make intelligent extracts which pertain to one's work. The knowledge of what has been done by practical men, gleaned from such columns as those offered by POWER, means economy in labor; items and kinks may not prove useful until months after perusal and then memory does not always hold in good stead. Using the pencil in "a scientific manner" will evolve a handbook of reference such as cannot be purchased at any price; its value to its owner and compiler lies in knowing where to find what is wanted at the right time. Thus, such a work should be properly and sufficiently indexed as it progresses, pages being left at the front or back of the book for the purpose. The notebook should be of a size easily carried on the person and of a volume of 300 to 400 pages.

Covering only fifty-two issues, a volume of POWER becomes a large and bulky affair; it finds a place in your library and its equivalent worth for reference is indisputable. As a book, it is useless in the field. To be of ultimate value the meat must be extracted and must be placed available in convenient form and the self-compiled handbook POWER, the cause and the effect, digested and noted intelligently, will prove a reference of illimitable assistance.

L. R. W. ALLISON.

Los Angeles, Cal.

Notes on Barometric Condensers

In the issue of August 2, Warren H. Miller contributes some notes on barometric condensers.

Several of the statements given do not conform with my experience.

Mr. Miller defines a barometric condenser as an ordinary jet condenser discharging through an ejector into a vertical tail pipe 34 feet long. This, to me, appears much too general a definition, as it would imply that there is only one kind of barometric condenser in service, which is certainly far from the truth.

On page 1401 Mr. Miller gives some figures regarding an installation of his which, evidently, he has not checked over.

He claims to have obtained a vacuum of 28.5 inches with 300 gallons of injection water per minute entering the condenser, which is presumably of the parallel-flow type, at 70 degrees and leaving the condenser at 118 degrees.

Now with this type of condenser it is seldom possible to get an injection discharge nearer than 20 degrees to the vacuum temperature. According to the figures published, Mr. Miller obtained an injection discharge temperature of about 20 degrees *above* that due to the vacuum temperature.

I figure that with the injection temperature given the vacuum obtained would hardly exceed 24.5 inches. Also, with the rise of temperature indicated, i.e., from 70 to 118 degrees, the ratio of injection water to steam would be in the neighborhood of 22 to 1. With this ratio and 300 gallons of injection water per minute, the quantity of steam handled would probably be,

$$300 \times 10 \times 60 \div 22 = 8200$$

pounds per hour.

With two engines developing 300 kilowatts each, the steam consumption per kilowatt per hour would equal 13.7 pounds, which would indicate an exceedingly efficient pair of engines.

Mr. Miller states that the fall in vacuum given was not due to air, but to the fact that the condenser was designed for 1000 horsepower on a 26-inch vacuum, and the load was far above this.

I fail to trace the overload mentioned, as the total horsepower of the four machines would only appear to be 1005, and it must be a very poor condenser that breaks down with an overload of 0.5 per cent.

On page 1402, Mr. Miller, in referring to the relative amounts of injection water required for surface and barometric condensers, states "it is more than likely that the actual figures of the former equal, if not exceed, those of the latter." This statement is incorrect. If the comparison were made between a surface condenser and a parallel-flow jet condenser, it would be approximately correct to say that the quantity of water for small condensers would be the same for both types of condensers, but with reasonably large condensers the surface type would require considerably less than the jet type.

If, again, we compared the relative quantity of water required for surface condensers and barometric countercurrent jet condensers, the difference would be still greater, but in this case in favor of the countercurrent jet condenser.

This is easily made clear when we consider that the "drop" or temperature difference between the vacuum and the injection discharge is usually about 6 degrees for the countercurrent jet condenser, 10 to 15 for the surface condenser and 20 degrees for the parallel-flow and ejector-type condenser.

It follows that the closer the injection-discharge temperature approaches the vacuum temperature, the greater will be the quantity of heat taken up by the water, and the smaller the quantity of injection water required.

The relative quantities of water required for different temperature conditions can easily be obtained from my figures published on page 918, November 30, 1909.

W. VINCENT TREEBY.

Goodmayes, Essex, Eng.

Packing a Feed Pump

In the August 9 issue of POWER, George Kramer wants to know how to overcome his boiler-feed pump packing troubles. Five years ago, when taking charge of a small mill plant, I was told that the boiler-feed pump had to be packed every three or four days. Thinking that the pump was at fault, I opened it up and examined it, but found it to be in good shape. I carefully packed it with a good grade of hydraulic packing, only to have the pump "slipping" as badly as ever after a week's run. After using four or five of the best brands of packing with the same result, I started to look for the trouble elsewhere and found it in the feed pipe. The pump was located close to the deep-well pump in the engine room. Water flowed to the pump from an open heater in the boiler room. The

water was discharged through a 1¼-inch feed pipe, which was about 70 feet long and had eight 90-degree elbows. The excessive friction in this long and crooked pipe made the load so great that the packing in the pump would not stand up under it. After moving the feed pump to the foot of the heater and coupling it up with a short pipe of the same size, I had no trouble at all with the packing.

I might also draw Mr. Kramer's attention to the fact that his feed pipe may be lined up with scale where it enters the boiler. This would have the same effect as a long feed pipe.

CHARLES FENWICK.

Duck Lake, Sask., Can.

Vibrations in Boiler and Piping

A few years ago I was troubled with vibrations in the piping and boilers, which were similar to that described by Mr. Davis in the August 9 issue.

In my case the vibration became more violent as the load on the engine increased, until the windows in the building rattled.

The vibration was noticed only when a cross-compound engine was running. This engine had cranks set 180 degrees and made 275 revolutions per minute. An examination of the valve setting showed it to be badly out of adjustment; the engine was doing most of the work in the head end of the high-pressure cylinder. The trouble ceased when the valve travel was equalized. It is very likely that Mr. Davis will find the source of the vibration to be at the engine and not at the boiler. Loose foundation nuts, or the nuts that hold the cylinder to the engine frame, will help to cause vibration.

J. W. BLAKE.

New York City.

Vacuum Cylinder Jacket

To determine whether there would be much of a decrease in the steam consumption of an engine if a vacuum were maintained in the cylinder jacket, a series of tests was conducted at the University of Wisconsin. The engine was a 50-horsepower compound machine.

An air pump maintained a vacuum in the jacket within a half inch of the barometer reading. If under these conditions an increase in economy were effected it was thought that in commercial work the vacuum could be maintained by a direct connection to the condenser. If there were an increase in economy only by the use of a higher vacuum it would certainly be impracticable for commercial use; therefore, the vacuum maintained in the tests was considered sufficient. The engine was run both simple and compound. Each of the tests was run with air in the jacket, with steam and with a vacuum. The six tests were each four hours long. The load was varied from one-quarter of the rated capacity of the engine to 25 per cent. above its rated capacity. Each load was carried for three-quarters of an hour and time was allowed between the runs for the engine to become adjusted to the new load. From the data obtained from the tests curves were drawn to show the economy of the engine under the various conditions.

In both the compound- and the simple-engine tests the greatest economy was secured when steam was used in the cylinder jackets. The economy curves of the tests during which air was used, a vacuum maintained in the jackets lay very close together. The vacuum secured slightly better economy at under- and overloads; the difference did not amount to more than 2 or 3 per cent.

Although these tests do not prove absolutely that a vacuum jacket around a steam-engine cylinder would not increase the economy, they do show that whatever effect it may have would not be great enough to be of practical importance.

RUBEN N. TRANE.

Milwaukee, Wis.

Engineers' Wages

The articles on engineers' wages that have appeared in the recent issues of POWER seem to cover the subject quite well; but, in considering this matter a very broad view is required because of the fact that in every plant the conditions are different and the payment of the operating force cannot be graded uniformly.

With many men the amount of time required to be put in is of more consequence than that of compensation. In any plant running 24 hours the matter to be disposed of is only the question of the length of the watches.

In the case of the factory plant where the usual running time is eight to ten hours, the engineer often has to run overtime and he may even be compelled to work on Sunday to do his repairing. In many instances he gets no extra pay for this work so that there is no encouragement to keep things up to the highest standard.

In addition to all this, if the engineer wishes to have a vacation or is prevented by illness from being on hand, the company deducts the amount from his salary, forgetting that by paying him they might give him such encouragement that he will become a more valuable man to them instead of a "sore head" who will leave as soon as he sees something better.

It is a curious fact that when the wages are only a small fraction of the operating expenses, business men will haggle over a difference of a few cents a day in the pay of the engineer when the burning of a ton, more or less, of coal to increase the production would hardly be thought of.

An employer is willing to lay out money to make a machine more efficient. I do not know of any better way in which to make a man more faithful than to let him know that he is considered necessary to his employers and to pay him a proportionate wage.

Many men think that because an engineer does not ask for more pay he does not want it. If they knew how some of the men feel about this they would realize that a raise gained by asking for it is considered as given grudgingly and because the employer feels that it is necessary.

Perhaps I have in mind an ideal condition of affairs but I am sure that if a more liberal policy were followed we would have better engineers.

To the employer I say, if you expect your engineer to work from 10 to 30 hours a week overtime doing piping, fixing belts and attending to numerous other jobs that rightly someone on the repair force should do, you expect too much. If you expect him to work all sorts of hours for a fixed salary, you expect too much. Please remember that you are dealing with men, not machines.

To the engineers I say that I think we should all take to heart the front-page editorial in the July 26 POWER for, having been through the same experiences myself, I can say that money is not everything. A position where everyone is pulling together is much nearer the ideal.

G. H. KIMBALL.

East Dedham, Mass.

Verdict on Canton Explosion

In reading the editorial in August 30 issue of your paper, "Verdict on Canton Explosion," I wish to say that in my opinion the only evidence that the cororner took into consideration as to the cause of the explosion was that furnished by people who were interested in covering up the real cause of the disaster. My reasons for saying this are, first, turning a stream of cold water into a red-hot boiler to cause a violent explosion of the same has been tried and proved a failure. In that case, where does Mr. Allen's evidence come in?

In all testimony heretofore given by all experts on violent boiler explosions that were caused by water hammer, it was distinctly stated that the water hammer was caused by suddenly releasing the steam pressure on a large body of heated water which contained an enormous amount of stored energy, and when the pressure was suddenly reduced the water flashed into steam and the safety appliance in the boiler would not take care of it. If this is true, how can anyone say that putting pressure on to the top of a body of heated water would cause a water hammer and cause the boiler with the lower pressure to explode? How can

anyone claim that the exploded boiler was safe for a working pressure of 100 pounds when, if that boiler came under the head of the Massachusetts State boiler-inspection law, it would not be allowed to carry 60 pounds working pressure? Does it not look as if there is something wrong in Ohio in regard to the law covering boiler inspection?

What right has the coroner to throw out the evidence of the only man that knew anything about the explosion, and then take into consideration testimony that was only surmise? The evidence given by Louis C. Hughes, who swore that the exploded boiler was cut into the battery 20 minutes before the explosion occurred, was rejected. And in the face of that evidence, how can a man who holds the position of coroner "square" himself after such a decision when, if a fair test had been made, it would have shown that the boiler was not safe for a working pressure of 65 pounds?

Who are the boiler men who have written congratulatory letters to the coroner on his findings and verdict on the explosion and the real cause of it?

I hope they are not the men I know who write editorials for POWER.

MICHAEL H. HARRINGTON.

Fall River, Mass.

The verdict of the Canton, O., coroner on the cause of the explosion of the boiler at the American Tin Plate Mill last May is peculiar in that the sworn testimony of the fireman, Hughes, was thrown out in arriving at a conclusion. Hughes testified that the exploded boiler had been cut in, that the safety valve had blown and that the boiler was connected and in service when the explosion occurred. Unable to account for the affair he ventured the opinion of explosives in the coal as the cause, even as other men have in the past. In announcing his verdict the coroner sums up by deciding the explosion was due to water hammer caused by cutting in the boiler in question when the pressure was higher in the line than that in the exploded boiler. Had he reversed this by giving the exploded boiler the higher pressure his argument would have appeared more reasonable. The facts that the damaged stop valve was found two-thirds open and that the body of the unfortunate Austin was projected several hundred feet, seem to have been the main reasons for arriving at the water-hammer conclusion. Engineers, boilermakers, firemen and inspectors are interested in the matter. They live, move and have their being around steam boilers, and explosions touch them deeper than anyone else. Employees may hear of explosions and insurance companies grumblingly pay the freight, but they live by these storehouses of danger called steam boilers.

Being one of the craft, may I not examine and question the verdict of the coroner in this case? First, it seems the testimony of the fireman Hughes was disregarded solely on account of Austin's body being projected to such a distance that it was decided that he was on top of the boiler at the moment of explosion. Grant this fact, any man of experience knows how seldom the stuffing box on a stop valve on a boiler is packed. It is never thought of, as the valve is used only when cutting in and cutting out. The packing is usually burned out long before repacking is done. With a knowledge of this fact is it not probable that opening the valve caused the gland to leak and that, finding half an hour later that this leak had become worse, Austin went on top of the boiler with a wrench to screw up the gland and the explosion then occurred? Any engineer or fireman with experience in handling plants of this character will substantiate the logic of this view. Of course, the nonpractical man never had his attention called to this. That the valve was found two-thirds open proves nothing, for in practice this is the common position when not closed. Few open wide a stop valve over a boiler.

With regard to water hammer, it may be said, had the explosion been due to this cause the water would have been projected like a shot to the top of the shell and the metal would have ruptured in the solid plate from head to head along the top as in other explosions on record. That it did not do so in this explosion disproves conclusively the water-hammer theory in this case. Had this explosion been due to water hammer caused by quickly cutting the boiler in when under a pressure considerably in excess of that in the other boilers, then the energy instantaneously liberated would follow the path of outlet, the steam pipe, and the water would be carried upward, striking the shell with a force sufficient to disrupt it at the point of contact exactly as in the explosion at Swift's plant in Chicago in 1902. Water hammer in boilers of this type results in rupture at the point reached by the projected water.

What then caused the explosion? Here was a boiler about sixteen years old, constructed with one sheet on the bottom extending from head to head and a similar one on top, as described in Mr. Monnett's article. The upper sheet tore away from the lower sheet by shearing the rivets in the longitudinal seams on each side. This construction has been condemned by all experts for reasons that have been explained in POWER many times. The seams were of lap-joint double-riveted construction with the flexure common to that design. If the plate be the weaker, cracks occur. If the rivet section in shear be the weaker, then the bending action long continued will result in shearing at mid-section, and granting failure at that point it follows the remaining rivets being weaker than the net plate give way by shearing.

In view of the above the verdict of the Canton coroner may be set aside as of no value to the men operating boilers. The explosion in my opinion points out again the danger in operating boilers of this construction, together with emphasizing the weakness of the lap joint. We should have a factor of safety high enough for safety and a yearly water test of 50 per cent. in excess of the calculated pressure on the one-sheet boiler. A factor of safety of 6 is not too high, as the horizontal seams cannot be seen inside or out. No examination short of a water test with the walls removed to permit the seams being examined is of any real value on boilers of this design, and this test should be supplemented by trams over the seams and by steel tape around the circumference of the shell at several points. That about 1½ boilers explode every day in the United States is by no means creditable to those engaged in supplying us with reservoirs for stored energy. Nor should the Canton explosion blame be shifted on the shoulders of a dead man by the exceedingly peculiar views of the Ohio coroner.

JOHN DODD.

New York City.

In a recent editorial mention is made of the report of the coroner on the cause of the boiler explosion at the works of the American Sheet and Tin Plate Company, Canton, O., on the afternoon of May 17, which is a repetition of the "whitewash" so obvious in the account of the occurrence published in the issue of May 31. The coroner was assisted in arriving at his conclusions by the testimony of Francis B. Allen, Osborne Monnett and also by Edwin Whelan, whose testimony before the coroner varied widely from his remarks, as published in the Canton press, a few hours after the explosion. Mr. Allen said the explosion was probably caused by water hammer, a phenomenon liable to occur whenever a boiler was cut into a line with others carrying either a higher or lower pressure.

Mr. Allen's statements as to the probability of a water hammer may have fitted a case where the explosion occurred at the time of cutting in a boiler but are hardly fit in the case where the boiler had, as the injured fireman testified, been cut in with the others for some 20 minutes when the explosion came. He had personally attended to that matter and was sure of it.

While expressing regrets for his lack of technical education, the coroner states two impossible conditions and selects one as the cause of the explosion.

It is to be regretted that no effort is made to make the use of steam boilers comparatively safe.

Middletown, O. P. B. MARTIN.

German Municipal Stations

By F. R. Low

The people of Germany, of much of Europe in fact, seem to be able to do things for themselves to a greater extent than the "self-governed" people of America have done. The cities generally own and administer not only their water supply but their gas and electrical works, their street-car systems, etc., and are able even to provide amusement for themselves through municipal concert halls and gardens, subsidized theaters, etc., without any of the dire consequences symbolized by "bureaucracy" and "paternalism" with which we are threatened when such self service is proposed.

Frankfort-on-the-Main is one of the richest as well as one of the largest, territorially, of the European cities. Years ago it loaned the king a sum of money, secured by an extensive wood contiguous to the city, and the debt has never been redeemed, so the city still has the broad expanse of territory, and an appearance of being well to do. The municipal central station furnishes current for the street and commercial lighting and for the operation of the tramways. A visit to it is a formal affair to be preceded by a call at the bureau and the making of an appointment.

The effect is quite different from an informal dropping in. One is expected. Massive gates are thrown open, the uniformed *portier* is ready with every attention and an engineer is waiting to conduct one about and exhibit and explain the works.

The first impression is that of elegance and permanency. The buildings are impressive in size and architecture, the floors are tiled, the walls are wainscoted with colored ceramics, everything is clean, quiet and orderly. One would no more think of throwing anything upon that spotless floor, or placing his hand upon the polished bright work than he would of throwing a cigar stub upon a parlor carpet or putting his shoes upon a satin-brocade lounge. We have some stations with tiled floors and walls, and we use some metal polish and elbow grease, but I never saw a station where a bit of disorder would be so apparent, where a leak would be such a desecration as here. I suppose that all this elegance means high first cost; it may be expensive to maintain this "dress parade," but it must conduce to efficiency, effectiveness, longevity; and the moral effect and enjoyment of the nicer surroundings and conditions ought to be worth the difference in the cost.

The engine room contains five turbines of the Parsons type built by Brown-Boveri, each of 3500 kilowatts capacity and four 1000-kilowatt Sulzer engines. Surface condensers with motor-driven circulating and dry-vacuum pumps are used, the water coming from the river Main. The steam pressure was 154 pounds gage with superheat to 575 or 600 degrees Fahrenheit and the vacuum 28 to 29.25 inches of mercury. The incoming water is 64 degrees, the outgoing 73 and the hotwell 77. Under these conditions the turbines use about 12.76 pounds of steam per kilowatt-hour.

There are four types of boilers in the station, having a total heating surface of 107,600 square feet for an aggregate of 30,000 horsepower of engines. Narrow chain grates are used, two to a boiler. There is one chimney 246 feet high and 10.5 feet inside diameter at the top and two others 164 feet in hight and 9.2 feet inside diameter at the outlet. Each boiler has its own economizer with 2368 square feet of heating surface each, heating the water from 77 degrees to 194 degrees Fahrenheit. Centrifugal feed pumps are used, each capable of handling 2472 cubic feet per hour against the boiler pressure when running at 2600 revolutions per minute.

Ados and Pintsch CO_2 recorders are used, the records showing from 10 to 12 per cent. of carbon dioxide.

In 1909, the station turned out 34,000,000 kilowatt-hours at a station cost of 1.32 cents per kilowatt-hour, to which must be added 0.6 cent for standing charges. Coal costs about $4 per ton. The average attendant is paid $1.32 for a nine-hour day.

At Cologne there is even less evidence of industrialism in the exterior appearance and approach to the combined water works and electric stations than at Frankfort. If it were not for the chimneys one would never imagine that the handsome buildings standing in a park filled with flowers, trees and shrubbery, surrounded with an ornamental iron fence and entered through an impressive portal, were devoted to pumping water and generating "juice." No adequate idea of the installation can be conveyed without photographs, and these with a description of the station by one of the engineers we hope to be able to present to our readers later. There are two electric stations, one with four engine-driven units of 1000 kilowatts each and one turbine of 2000 kilowatts, and in another building three turbine units of 3000 kilowatts each. The pressure is 160 pounds gage; the temperature is 660 degrees Fahrenheit at the boilers and 540 at the engines. They use water from the city mains for condensing, the city water works alongside being thus their circulating pump; and, using a Brown-Boveri dry-air pump, get a 95 per cent. vacuum. The circulating water is thrown away after passing through the surface condensers, although it must be collected from wells. There are four chimneys, each 246 feet in hight and 13 feet in outside diameter at the top.

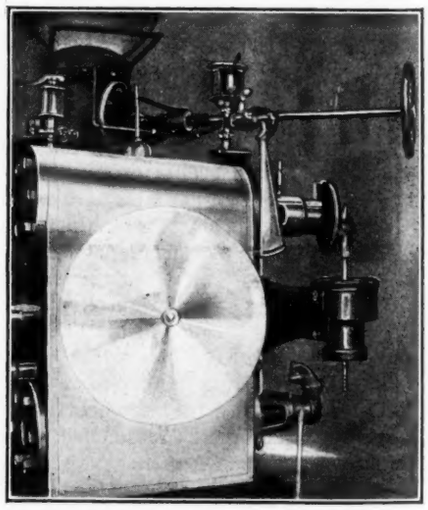
The pumping station is a high-vaulted room with gothic windows and stained glass like a cathedral. There are five large horizontal pumps made by Sulzer Brothers.

In neither of these stations did I detect a leak and neither would own to any trouble with the piping, notwithstanding the use of superheated steam. They never had had any trouble. They used steel pipe expanded into flanges, avoided the use of fittings wherever possible by using bends instead, and used cast steel when fittings were required as well as for valve bodies.

Position of Throttle

The illustration shows the arrangement of the throttle valve on a Corliss engine found running in a small steam plant at Bristol, Va. The throttle is so set that the stem comes a trifle inside the corner of the cylinder on the valve-gear side. The engine has two eccentrics, and the advantage of the valve-stem extension is at once apparent to the man who is familiar with this type of engine.

The throttle is conveniently placed for



SHOWING POSITION OF THROTTLE

the engineer to operate in stopping the engine at the proper point for starting. It is certainly easier to handle the valve gear with a throttle of this design than if it were of the short type set with the valve stem midway between the valves, which would necessitate the engineer reaching over to catch the throttle wheel in order to get steam into the cylinder, either to push the crank over the center or prevent it from passing the quarter.

Some Interesting Gasket Kinks

By R. O. Richards

The author tells how to "lead" a gasket, how to cure curling and gives a number of useful kinks concerning gasket troubles.

In Fig. 1 is shown an ordinary way of connecting the three drums of an Aultman & Taylor boiler. The arrangement represents such an inflexible construction that when one of the gaskets *A* or *B* blows out, it is a most difficult matter thoroughly to clean the flanges without disturbing some of the other gaskets. The quickest, and in the end the cheapest, way to renew the packing in this case is to break the joint *C* and remove the elbow. If the gasket at *C* has been thoroughly graphited, only the packing of the affected joint need be renewed. The best way to "lead" a gasket is to mix the graphite with a little water, and not with oil, as often oil besides attacking the rubber will, when dried, cause the gasket to stick.

If a joint such as that shown at *D* leaks, it will be necessary to slacken on the bolts of the flanges at *A, B, E* and *F* sufficiently to allow for prying open the joint *D* with thin wedges. The task of removing the old packing, owing to the limited opening, is arduous and vexing. An effective tool for such work is shown in Fig. 2. Here *A* is a flat piece of steel ⅛ of an inch thick. The entering

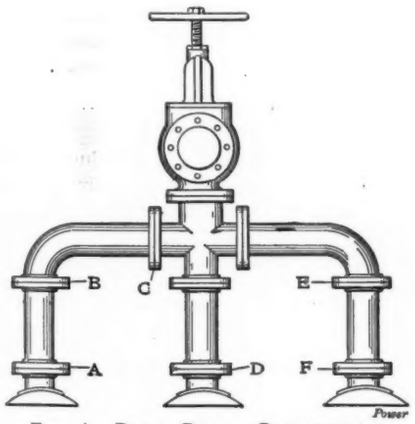


FIG. 1. RIGID DRUM CONNECTION

edge is ground to a one-sided sharp edge. By manipulating the nuts *B, A* is forced between the flanges, and removes the old gasket more satisfactorily than would an old saw.

It is often difficult to be certain that the flanges have been thoroughly cleaned. If a piece of brown paper, lightly graphited, is inserted in the joint, and then the flanges are allowed to pinch it, the high spots are easily located. If the old gasket has any asbestos in its make-up, to soak it with water will often expedite its removal. When inserting the new packing a difficulty often met with is caused by the curling of the gasket which insists on dropping down the pipe opening rather than remaining between the flanges. The common remedy is to insert a sheet of tin in the joint and slide the gasket over it, but often the opening is so small that the tin causes the gasket to bind. A good method is to cut the gasket with two fairly long ears, and cement, with a little shellac, a portion of one ear to a large piece of strong brown paper. The gasket can

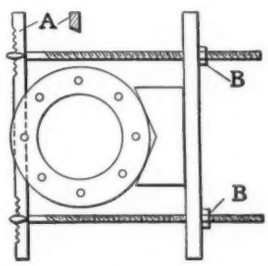


FIG. 2

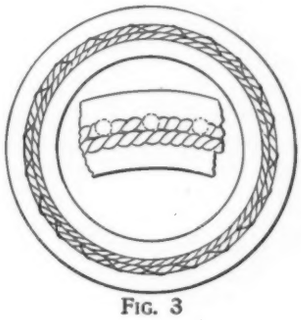


FIG. 3

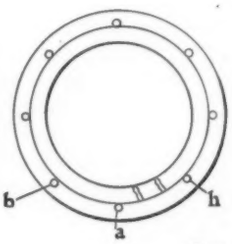


FIG. 4

then be coaxed through with but little trouble. When in place the cemented part of the ear is cut off, and the paper removed. In confined places, however, the use of metallic gaskets will save much time and annoyance, and when trouble arises they are very easily removed. When flanges are covered, often a joint will leak considerably before it will show through the nonconducting material to any extent and the result is scored flange surfaces. If this proves serious a length of pipe should be removed and a metallic cement applied to the grooves. When replacing the pipe care should be taken to prevent the furrows from again falling in line with one another. A gasket which proved successful in a troublesome joint that failed to line up properly is shown in Fig. 3. A ring of holes was punched in an old, flattened-out copper gasket, then a three-sixteenths inch spool packing composed of several strands of good, strong material was woven through the holes, so as to make a continuous line. As the weaving progressed, the packing was gradually thinned down by cutting off some of the strands, so that diametrically opposite to where the weaving started, the packing is less than ⅛ of an inch in thickness. A ring of the same material, gradually thinned down in the same manner, is then cemented with shellac close to and on the inner side of the woven packing. The whole is now carefully beaten down so that it will enter the joint; the thinnest part, of course, was placed on the side where the flanges are nearest together. As the packing encircles both sides of the copper sheet, it allows of considerable lack of alinement in the flanges. The gasket must be "followed up" for a few days until the packing sets.

A gasket containing much rubber in its composition should be tightened up very evenly. To squeeze hard on the bolts the first time round will result in wrinkling the packing. This is graphically shown in Fig. 4. If bolt *a* is tightened hard, followed by the tightening of the others in consecutive order, the rubber will stretch and wrinkle between bolts *h* and *a*.

In some plants considerable trouble is experienced with gaskets from lack of proper support for the pipes. The following two examples are given to illustrate:

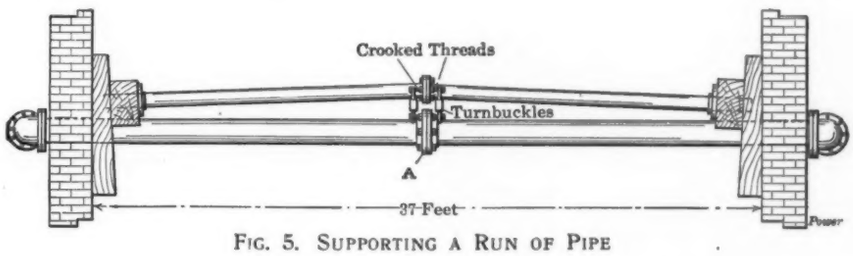


FIG. 5. SUPPORTING A RUN OF PIPE

At a certain mill it is necessary to pass a 4-inch pipe carrying steam at 110 pounds pressure over a 37-foot roadway between two low buildings. No support could be placed under the pipe, and in consequence considerable difficulty was experienced in keeping the gasket *A*, Fig. 5, tight. The hight of the

building does not allow the use of braces or guy ropes, and the pipe is at the lowest level allowable.

The problem was solved by taking two lengths of 2-inch pipe and cutting long crooked threads on one end of each. Securing flanges to these, the pipe was placed above the steam main, and set to rest on the brackets as shown in Fig. 5. The two single flanges at each end were bolted loosely but securely to these, allowing ample travel for contraction during the winter months. Four small turnbuckles connect two bolts of the middle 4-inch flanges, to two bolts of the supporting 2-inch flanges. In winter a couple of layers of tar paper cover the two pipes in such a manner that what little heat escapes through the covering of the 4-inch main will keep the support pipe warm, thereby preventing undue contraction in zero weather.

In another mill where a Climax boiler is in service, considerable difficulty was experienced in keeping the gaskets *A* and *B*, Fig. 6, from leaking. It was surmised that the piping was not sufficiently flexible, and that a long sweep should have been used in place of the 45-degree piece, to allow the boiler to expand upward, without undue strain on the flanges *A* and *B*. As it would entail considerable expense to alter the piping, it was decided to try a movable support, so that the boiler expansion could be thrown more on the long pipe leading to the engine. A 2-inch pipe in three pieces was set solidly in an upright position on the boiler-room floor. A slot was cut in the upper section for the two levers *C* to enter under the loose forked head *D*. Attached to the levers by the wrought-iron rods *G* are the weights *E* which, through the medium of the levers that have their fulcra at *F*, have been calculated to balance the weight of the steam main above them. Thus, as the boiler expands and raises the steam pipe, the forked head *D* will rise with it, and in a large measure maintain a uniform strain on the flanges at all times. The flange beneath the weights was thought necessary as a precaution against accident by the stripping of the rods *G*. Use was made of it by bolting to it hooks for the very convenient hanging up of the fire tools.

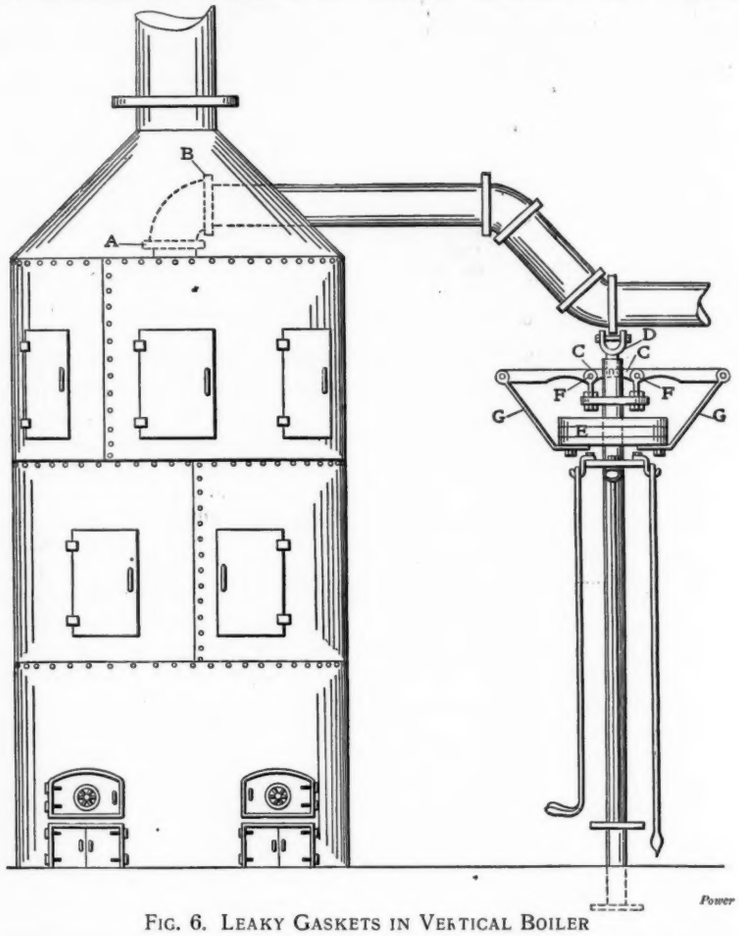
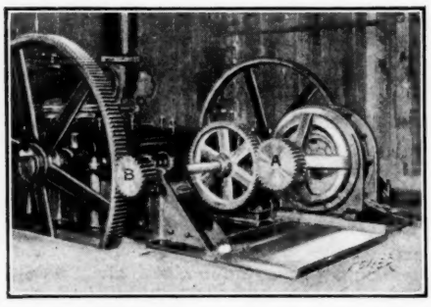


FIG. 6. LEAKY GASKETS IN VERTICAL BOILER

Rawhide Pinions Stop Vibration

Rawhide pinions are usually considered merely as a means of stopping noise on medium- and high-speed drives and by far the largest percentage of them are used for that purpose. It is a matter of engineering experience, however, that rawhide is beneficial on gear drives where there is vibration from irregular load, etc.



LOCATION OF NOISELESS PINIONS

This is well illustrated in the instance of the 1750-gallon quintuplex pump in the power plant of the Parral Power and Reduction Company, Parral, Chihuahua, Mexico. This pump, as shown in the illustration, is geared through double reduction to an induction motor and furnishes the circulating water for the condenser.

Originally the pump was driven entirely by cut-steel pinions and cast-iron gears. The pump was of so light a pattern that there was considerable spring in both shaft and frame. The result was constant annoyance from broken gear teeth and in addition to gear renewals, there was quite an expense due to the power loss of running the engines noncondensing while pump repairs were being made. The chief engineer had about decided to abandon the pump and replace it with another of different design when someone suggested the use of rawhide pinions. Accordingly, four "New Process" pinions were substituted for the four steel pinions. Two of these are shown in the photograph, one at *A* on the motor and the other at *B* meshing with the big gear at the left. The other two are on the other side of the motor and placed symmetrically to those shown. These rawhide pinions were put into service over two years ago and there has not been a moment's trouble with the gearing since. In fact, the pump has been out of service only long enough to repack the plungers and replace the rubber valves.

Rawhide where properly cured and machined makes up into a gear or pinion that is much the same as metal, except that it has no metallic ring and is more elastic. This elasticity is highly advantageous on motor and other drives in that it absorbs the shock as large gear teeth come into contact, and it cushions the irregularity of load due to the reciprocating movement of parts in machine tools or geared power-plant apparatus.

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Power and The Engineer

Editorial

Engineering Calculations

Accuracy with some people is instinctive—they practice it in every thought and action; with others it has to be cultivated through severe mental discipline, and they have to be continually on their guard against carelessness. No one will deny that accuracy is a desirable attribute, yet there is always the chance of the exceedingly accurate person becoming absorbed in the details without giving due attention to the main points. This is especially true with engineering calculations; here it is almost as bad to use unnecessary refinements as it is to carelessly use a number of crude approximations. From this it should not be inferred that precision may be neglected in the purely mathematical operations; it means that forethought and descrimination are required in determining the necessary degree of accuracy. This involves an understanding of the relation which the calculation bears to the problem under consideration, in order that the desired result may be obtained without unnecessary labor.

Many problems involve assumptions or factors that cannot be accurately measured and it would be absurd to carry out the calculations to the third or fourth decimal place. For instance, in computing the load that a certain member would carry, the assumption is made that the point of rupture of that particular material is 50,000 pounds per square inch. Now, this material may fail at 45,000 pounds per square inch or it may withstand 55,000 pounds per square inch; hence, the futility of carrying the computations to a high degree of refinement.

If it is desired to find the size of pipe through which a certain quantity of steam would flow under given conditions, it is sufficiently accurate to use 3 1/7 instead of 3.1416 as the value of π in finding the cross-sectional area of the pipe, for the reason that a number of indefinite factors, such as the drop in pressure due to condensation, friction, etc., enter into the problem and make a really accurate predetermination of results impossible.

Again, in figuring the indicated horsepower of a steam engine from an indicator diagram, if a slide rule be used the result will be about as near the true horsepower as would be the case if the problem were figured out by long hand. For the error in finding the area of the indicator diagram and the fact that the steam pressure in the indicator may not exactly represent that in the cylinder, make the result, at the best, only approximate.

On the other hand, there are certain engineering calculations which require a high degree of accuracy. Consider, for instance, the problem of laying out a tunnel under a river. The civil engineer must use the utmost accuracy in establishing his lines in order that the construction, begun simultaneously from both sides of the river, may meet at the center.

The advantage of being able to size up a problem at a glance with the exercise of proper judgment as to the degree of accuracy required, increases with experience. In the computing departments of large firms a vast saving in time and labor may be effected by the intelligent use of approximations.

The Sacrosanct Boiler Owner

One of the proud privileges of the American citizen is that of destroying life and property without let or hindrance, provided certain lines of procedure are followed. He may only to a limited extent kill with adulterated and poisoned food stuffs; liquid exhilarants and soothing beverages may contain only prescribed percentages of poison, and children of all ages may not be indiscriminately ground into profits. But almost anywhere in this country, with few exceptions, a steam boiler with its potentiality for the destruction of life, maiming of limb, spreading of fire and what not, may be installed and operated without question from any source whatever. If it were not so tragic in its consequences it would be ridiculous.

It is not necessary to call attention to the alarming rate at which the destruction of life and property is increasing as the result of boiler explosions in the United States to show that compulsory and intelligent inspection of all steam boilers, used for any purposes whatever, is fundamentally requisite for common safety.

If a building is to be erected or repaired, passers-by on the sidewalk are protected against danger from falling material by an arcade of heavy planking. But under the protected sidewalk or in the basement of the building there may be installed without question any number of steam boilers, even though they be known by the builder, the dealer and anyone else familiar with the subject, to be unsafe for the purposes intended, and

the passer-by and the worker in the building are helpless while the owner, who is seldom or never on the premises and is the one person on whom rests all the moral responsibility for disaster, is hedged about by the protection of the custom that allows the unrestricted installation of such apparatus. When an explosion occurs, as a salve to the conscience of such owners, if they have any, the coroner usually renders an innocuous verdict which is arrived at in some cases by frankly ignoring evidence of criminal negligence which is submitted.

How long is this condition of affairs to continue?

The Inaccessible Boiler

It is an unfortunate circumstance that stationary steam boilers are so frequently placed in positions difficult of access, making it a hot and disagreeable task to properly inspect them when in operation. The top of the boiler, in this class of installation, is a place to be avoided except when one of them is to be cut in or out, and then on account of the intense heat no more time than necessary is spent in the operation. Leaking seams and flanges are sometimes allowed to blow for long periods in hot, inaccessible places over the boilers, as repairs are put off as long as possible on account of the disagreeable work the job entails.

In the comparatively cool and comfortable engine room the engineer can examine his engine, indicate it and at his leisure make adjustments, all of which are important from an economical standpoint. These adjustments, however, are for economy only, while the examination of the boiler is for safety, which is of much greater importance. Boiler seams are frequently embedded in the brickwork of the setting so as to be totally inaccessible for examination, while other parts of the shell are covered with brick or nonconducting material and left for long periods without inspection. Conditions surrounding the boilers should, as far as possible, be made comfortable and all parts should be easy of access to the end that examinations, whenever made, shall be so thorough as to lessen materially the chances for disaster.

Following the scalding to death of one man and the injuring of another while rolling tubes in the firebox of a locomotive boiler at the Chicago & Northwestern shops, the chief boiler inspector of the city of Chicago addressed a letter of protest to the officials of the company, calling it a crime and a cruelty to order any human being into a firebox to repair a boiler under pressure or containing water at or above the scalding point. This view is to be commended not only from the humanitarian standpoint but from that of cold-blooded self-interest on the part of the owners.

Comfortable workmen will do good work, and good work is what is required when boilers are under consideration. There is no apparatus about which the engineer should be more particular, and on the other hand, there is no apparatus which suffers the danger of being slighted more than the hot, crowded, inaccessible boiler. Whoever is responsible for the layout of a boiler room should by all means bear these facts in mind and as far as possible make accessibility for inspection and convenience of operation the leading features of the design.

Inches or Pounds?

One of the incongruities of modern engineering practice is the use of one unit of measurement in discussing the condition of steam or other media when dealing with pressures above atmospheric and the use of a different unit when the pressure is less than atmospheric. That is, we talk of steam at a hundred "pounds pressure" but speak of a vacuum of so many "inches of mercury." This is all right, of course, so far as vacuum in the abstract is concerned; when one is speaking merely of a vacuum it is just as convenient to measure it in inches of mercury, perhaps, as any other way. But in view of the intimate and indispensable relationship between vacua and steam, in power-plant engineering, it would seem more consistent to express degrees of vacuum in terms of pressure—that is, to stick to one kind of unit throughout the scale of pressures. "Twenty-eight inches of mercury" means absolutely nothing without the commonly-accepted interpretation, which involves the application of a conversion factor and an assumption of atmospheric pressure; but "one pound absolute pressure" means precisely what it says, "per square inch" being commonly understood. Furthermore, no inconvenience of speech is entailed. It is just as easy to say "one and a half pounds" as it is to say "twenty-seven inches," and the former is not only more descriptive but absolutely devoid of ambiguity.

By all means let us measure condenser pressures in the same units as boiler pressures. "Inches of mercury" have no place in a steam plant nowadays.

Do It Right or Quit

Did you ever hire a laborer to dig post holes eighteen inches in diameter and thirty deep, and obtain the pleasing result of an ill-assorted lot of cavities ranging from twelve to sixteen inches across the top, eight to twelve inches across the bottom and eighteen and twenty-four inches deep?

Or did you ever have a room papered by a man who manifested a cheerful disregard for pattern-matching at the seams and an optimistic faith in the ability of the old paper to hang on to the wall and sustain the weight of the new paper?

If you ever had either of these experiences or any others of a similar kind, you can readily imagine how your employer feels when you ignore the pounding of a loose box, or scrape a pair of brasses to a "near-enough" fit, or carry a fire bed two feet thick in spots, or try to stop a leaky stuffing box by jamming the gland in instead of repacking the box, or do any of the other hundreds of sloppy, shirking things that indicate either a half-baked mentality or a dishonest willingness to do as little as you can without getting "fired."

If you are too lazy to do things as they ought to be done, or you don't think you are getting paid enough to justify that much trouble, get out and let a real man have your job—you will never make anything of it or of yourself.

Smokeless Combustion

Smokeless combustion is a subject that has recently been given a good deal of attention and as a consequence many improvements have been made in the boiler furnace.

Engineers are no longer satisfied with the construction of side walls and bridge-walls and the setting of grates in the most convenient manner; they are realizing more and more that boiler furnaces should be built so that combustion will be complete before the gases strike the heating surface of the boiler.

Bituminous coal of average grades can be burned without smoke, providing proper equipment and firemen who will handle the fires and apparatus intelligently are employed. One thing is certain, a good stoker or furnace, improperly set, will not do as good work as an inferior stoker or furnace well set.

It is the opinion of many engineers that bituminous coal cannot be burned without smoke when hand-fired, because the fireman is altogether too variable a factor. This may be true in many small plants and perhaps is in some large ones too, but if proper supervision is maintained over the fire-room force, satisfactory results may be attained.

In small steam plants the problem of smoke prevention may be solved either by hiring capable and careful firemen or by installing suitable mechanical stokers. The best results can be obtained from hand firing only when the charges of fuel are frequent and the amount small. The success of the mechanical furnace is largely due to the fact that the fuel is fed continuously, and the nearer hand firing can be made to approach this condition, the better will be the results.

Firemen who are obliged to fire coals containing large percentages of heavy hydrocarbons have greater difficulties to overcome than if coals of other grades were burned, but with a well designed furnace burning an ordinary grade of coal there is small excuse for the fireman to offer if he is guilty of maintaining a smoky stack.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it.

Steam Required to Heat Water

How many pounds of steam at 64 pounds absolute pressure per square inch are required to raise the temperature of 300 pounds of water from 40 to 130 degrees Fahrenheit, the water and steam being mixed together?

L. J. K.

One pound of steam at 64 pounds absolute pressure per square inch contains 1178.2 heat units above 32 degrees, of which it will give up 1080.31 in cooling to water at 130 degrees. It will take 89.84 heat units to raise one pound of water from a temperature of 40 degrees to 130.

To raise 300 pounds of water through the same range will require

$$300 \times 89.84 = 26{,}952$$

heat units and will take

$$\frac{26{,}952}{1080.31} = 24.939$$

pounds of steam at 64 pounds absolute pressure per square inch.

Superheated Steam

Why does not superheated steam have a temperature due to its pressure, and does it not expand in superheating and thus increase its pressure?

F. L. J.

By definition superheated steam is steam having a temperature higher than that due to its pressure. In superheating it expands to a slight degree if the pressure is constant but if the volume is constant superheating will increase the pressure. In ordinary practice the superheat increases the volume so slightly that the rise in pressure is not appreciable.

Engineers' License Laws

What States have engineers' license laws, and what is required to obtain a license?

W. F. S.

Massachusetts, Minnesota, Montana, Ohio, Pennsylvania and Tennessee are the only States having laws requiring the examination and licensing of engineers and firemen. But several States have laws which permit municipalities to pass license ordinances. In Baltimore, Md.; Buffalo, N. Y.; Chicago, Ill.; Denver, Colo.; Detroit, Mich.; Goshen, Ind.; Jersey City, N. J.; Kansas City, Mo.; Lincoln, Neb.; Los Angeles, Cal.; Memphis, Tenn.; Mobile, Ala.; New Haven, Conn.; New York, N. Y.; Niagara Falls, N. Y.; Omaha, Neb.; Peoria, Ill.; Philadelphia, Penn.; Rochester, N. Y.; Santa Barbara, Cal.; St. Joseph, Mo.; St. Louis, Mo.; Sioux City, Ia.; Spokane, Wash.; Terre Haute, Ind.; Yonkers, N. Y.; Fulton County, Ga., and in the District of Columbia engineers are required to have licenses. To obtain a license as engineer, one must show that he has the necessary experience and intelligence to enable him to operate steam boilers and engines with safety.

Link Motion Valve Setting

I am running a reversing engine with the common link motion and would like to know how to set the valve if it should become necessary.

B. M. C.

Put the reversing lever in one end notch and see that the valve stem and eccentric rod are of the right length, then put it in the other end notch and see that the other eccentric rod is of the right length. Then with the engine on the center set the valve the same as in the case of a single eccentric, trying with the lever in full gear both backward and forward.

Overtravel of Valve

What is meant by the term "overtravel?"

U. C. G.

Overtravel is the amount of movement of the valve above that necessary to give full port opening. To give full port opening a slide valve must move twice the width of one port and twice the lap. If the valve travel exceeds this, it will overtravel.

Leather Belting

Should the grain or flesh side of a leather belt run next to the pulley, and why?

P. C.

Leather belts should be run with the grain side to the face of the pulley. This side is harder and smoother than the other and makes a better contact with the face of the pulley. This side is not as strong as the other and the wear, if any, should be on the weaker side. Belts with the grain side next to the pulley will transmit one-third more power, with the same tension, than those wit hthe flesh side next to the pulley.

Strength of Butt Joint

Where is a double-strapped butt joint the weakest?

A. S. M.

Usually along the line of the outer row of rivets.

Per Cent. of Condensation in Feed Water

Using an open heater and exhaust steam for heating feed water, what percentage, by weight, of the feed water will be due to the condensation of steam, assuming the original temperature of the water to be 80 degrees Fahrenheit and the final temperature 212 degrees?

E. L. W.

One pound of steam at atmospheric pressure contains 1150.4 heat units. In condensing to water at 212 degrees, it will give up

$$1150.4 - 180 = 970.4$$

heat units. In raising from 80 to 212 degrees, one pound of water will absorb

$$180 - 48.3 = 131.7$$

heat units. As each pound of steam will give up 970.4 heat units in condensing to water at 212 degrees, it follows that one pound of steam at 212 degrees will heat

$$970.4 \div 131.7 = 7.36$$

pounds of water from 80 to 212 degrees, making 8.36 pounds in all. As one pound of this is condensed steam the percentage is

$$1 \div 8.36 = 0.119, \text{ or } 11.9 \text{ per cent.}$$

Pitch of Rivets

In a boiler the plate is 3/8 inch, the diameter of the rivets is 13/16 inch, and the efficiency of the seam is 71.7 per cent. What is the pitch of the rivets?

C. G. F.

In a correctly designed seam its strength is that of the uncut plate in the outer row of rivets. This strength is expressed by the equation

$$\textit{Efficiency} = \frac{\textit{Pitch} - \textit{Rivet diameter}}{\textit{Pitch}}$$

Substituting the values given in the example the formula reads

$$\frac{p - 0.8125}{p} = 0.717$$

$$p = 2.84 \text{ inches.}$$

New Power House Equipment

The Ray Automatic Feed Water Purifying System

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news.

This system consists of a settling tank arranged on the outside of the boiler setting at the rear. This tank is connected to the boiler and feed pump, as shown in Fig. 1. Details of the tank are shown in Fig. 2, where *A* represents a steel tank; *B* a pipe entering the boiler shell, if it is a return-tubular boiler, or the drum, if it is a water-tube boiler, just below the water level; *C* the feed-water pipe with a nozzled end which forces the feed water down into the tank, and *D* a drain pipe passing water from the machine to the boiler, usually through the boiler blowoff.

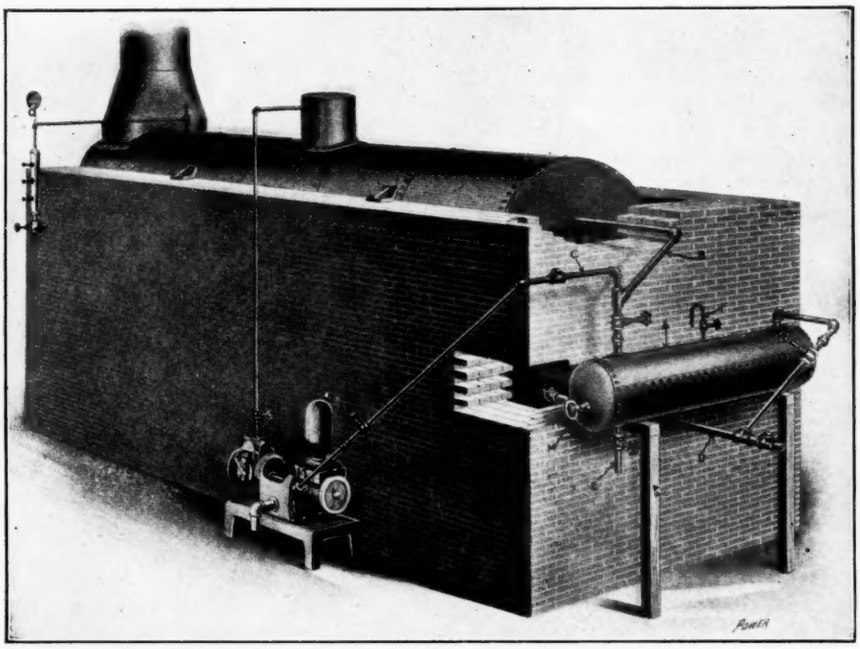


FIG. 1. SHOWING SETTLING TANK AND CONNECTIONS

The pipe *E* is the blowoff for the tank; *F* is an oil separator, air cock and water-test valve; *G* is a filter and strainer through which all water passes to the boiler; *K* is a copper elbow passing water to the oval end of the tank, creating an eddy and *M* is a scraper by means of which the tank is cleaned.

The action of the system is as follows:

The rapid circulation of the water in the boiler sets up a current through the pipe *B* to the settling tank *A*, and back to the boiler through the pipe *D*. The velocity of the water which enters the Y through the pipe *C* acts in the manner of an injector and draws an increased amount of water through *B* into the tank *A*.

The settling tank is so proportioned that the water passes through it slowly, and all matter held in suspension that is heavier than water, during the passage from the pipe *B* to the pipe *D* settles to the bottom of the tank, it is claimed.

Oil and the lighter particles rise to the surface of the water, where, due to the fact that the pipe *D* projects into the tank, it is held till drawn off through the valve *F*.

To remove sediment from the tank, the valves in both inlet and outlet pipes should be closed. The valve *F* should then be opened until the oil is blown off, if there is any, and then closed. The valve *E* is then opened and the greater part of the sediment is blown off and the remainder is drawn slowly toward the blowoff, by means of the scraper *M*, until it is all blown out. In refilling the tank the valve on the pipe *D* may be left closed and the valve on the pipe *B* opened, till the tank is filled, thus taking the water from the top of the boiler.

By taking a volume of hot water from the boiler just above the flues through the pipe *B*, a continuous surface blowoff without any waste of hot water is obtained, as it returns to the boiler with the feed water through the pipe *D*.

By reason of this hot water from the boiler mixing with the feed water from the pipe *C*, it is claimed that the reagent, if any is used, is instantly taken up and the temperature of the feed water is raised sufficiently high to drive off the carbonic acid gas, thereby liberating and depositing in the tank all the carbonates as sediment.

The operation of the system on all

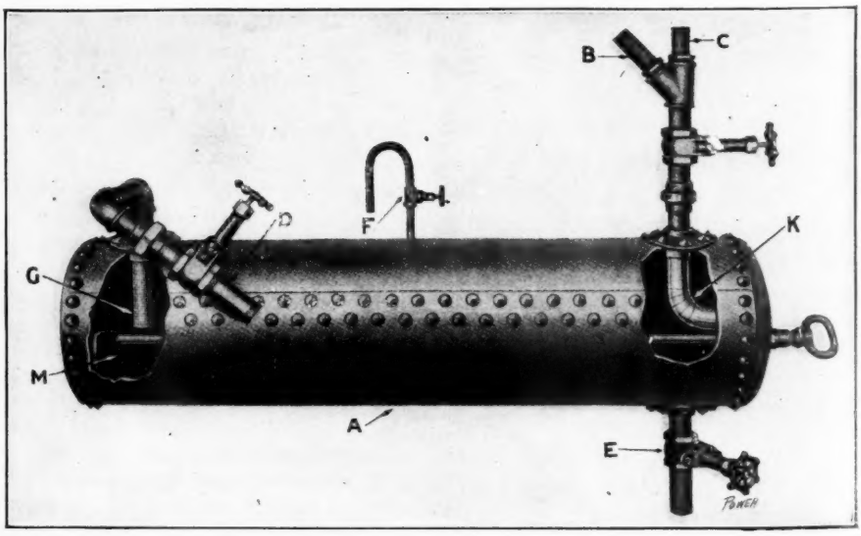


FIG. 2. DETAILS OF TANK CONSTRUCTION

types of boilers is substantially the same. The outflow pipe *B* is always connected to that portion of the boiler just below the water line, towards which the water on the surface flows. In the case of such boilers as the Stirling, where the water in the upper drum does not flow toward either end, perforated pipes are placed just below the water level in each drum, and connected to the pipe *B* extending the full length of the drum. The return pipe is usually connected to the boiler blowoff, especially in the case of return-tubular boilers.

This system is made by the Ray Steam Specialty Company, Kansas City, Mo.

The Wiechmann Turbine Tube Cleaner

The accompanying illustrations show the characteristics of a new line of turbine tube cleaners which are about to be placed on the market by the Clyde Ma-

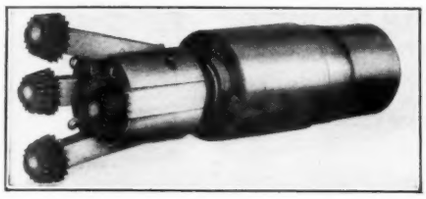


FIG. 1. WIECHMANN TURBINE TUBE CLEANER

chine Works Company, Thirty-ninth and Union avenues, Chicago, Ill. The styles shown are adapted for both water-tube and fire-tube boilers and different styles of heads are provided for scales of different character.

Fig. 1 shows an exterior view of the standard cleaner for water tubes, the feature of which is the simplicity of the cutter head and the ease with which the elements may be removed from the machine and replaced or repaired when necessary. All parts of the head are made of tool steel, tempered to withstand the hard usage, and, as far as possible, all wearing parts have been eliminated.

Fig. 2 is a sectional view of the cleaner, showing its simplicity of construction. The cutter's arms are removed from the head by taking out a small brass cotter pin which holds the shaft on which the arm revolves. The cutter wheels may also be removed by withdrawing the key holding the cotter pin in position. There is no possibility of this key working loose and falling out on account of both sides of the main body of the cutter head working in close machine fit with the pin, as shown in Fig. 2. Another important feature of the head is the manner in which the cutter arms are interlocked, thus operating in unison, due to a projection on the two longer arms engaging a slot on the two shorter arms.

The arms are controlled by suitable stops in such a manner as to permit the opening up of the same only to the maximum of the inside diameter of the tube being cleaned, thus preventing loss of power by the cutter working on the metal of the tube itself. As the centrifugal force of the cutter heads reinforce each other, the machine has four times the momentum that one freely swinging arm would have in meeting hard sections of scale.

The machine operates on ball bearings which are easily removable and are adjustable at will. The motor consists of a single turbine wheel upon which water acts through suitable nozzles. The wheel is incased in a steel band which reduces leakage around the outside of the buckets and increases the efficiency of the motor. Fig. 3 shows an application of the cleaner to a different style of head.

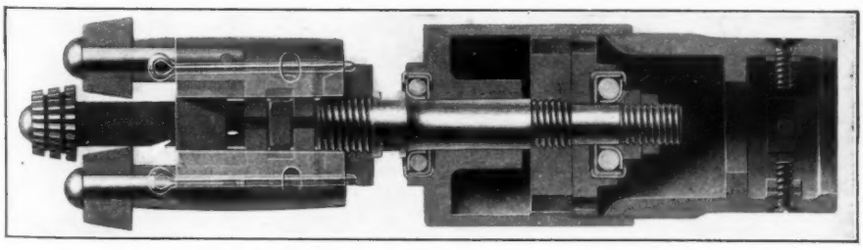


FIG. 2. SECTIONAL VIEW OF TURBINE TUBE CLEANER

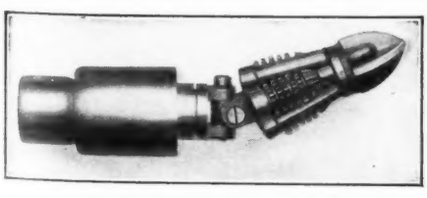


FIG. 3. DEVIL HEAD TUBE CLEANER

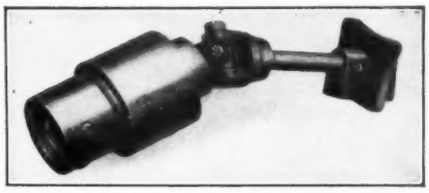


FIG. 4. CLEANER FOR FIRE-TUBE BOILER

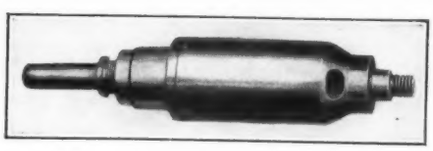


FIG. 5. AIR MOTOR FOR CLEANING FIRE OR WATER TUBES

Fire-tube boilers are cleaned with the head shown in Fig. 4. The vibrations are produced by the cutter head being hung in an eccentric position with regard to the turbine itself.

For operation with air or steam pressure, a specially designed motor containing rotary pistons is made, an exterior view of which is shown in Fig. 5. By using suitable heads for the duty to be performed it is claimed that greatly increased cleaning efficiency is obtained, due largely to the accumulative effect of the centrifugal force in the standard turbine head shown in Figs. 1 and 2, which enables it to work its way through any scale of varying thickness and composition which it is liable to meet in practice.

Jefferson Flange Union

It is claimed that this is the first three-part flange ever made that will always make a tight joint without the use of a gasket. Fig. 1 illustrates the general design.

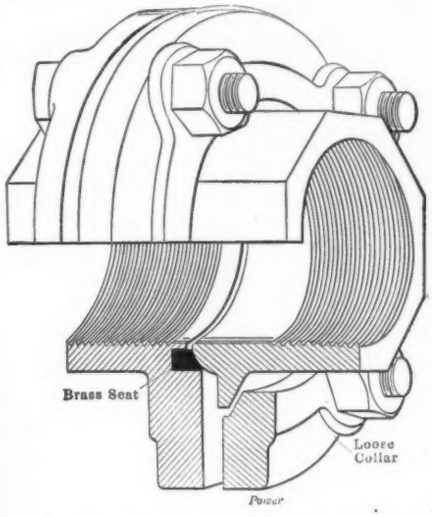


FIG. 1. JEFFERSON FLANGE UNION

The body part is made of a particular grade of malleable iron. The seat is made from drawn brass tubing. The joint is spherical and thoroughly ground and the two flat disks do not come together. This

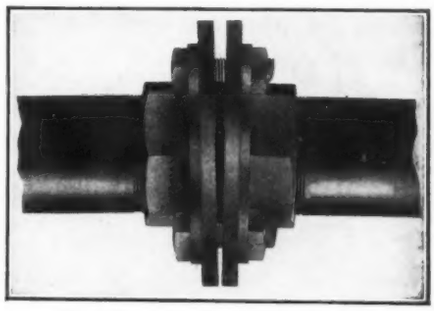


FIG. 2. UNION ON PIPE OUT OF ALINEMENT

allows a tight connection to be made, even if the pipes are out of line, as shown in Fig. 2.

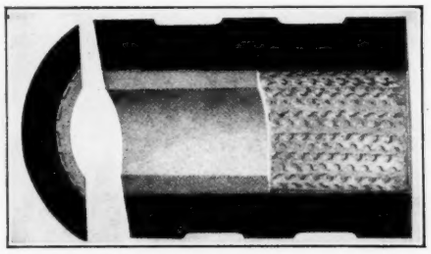
The loose collar allows the bolts to be applied at once. From this feature and the fact that no gasket needs fitting, much time is saved when using this style of flange, which is suitable for pressures up to 300 pounds.

It is made by the Jefferson Union Company, Lexington, Mass.

The Bollinckx Patent Bearing

The accompanying illustration shows the method employed by H. Bollinckx, Brussels, in securing bearing metal in bearing boxes.

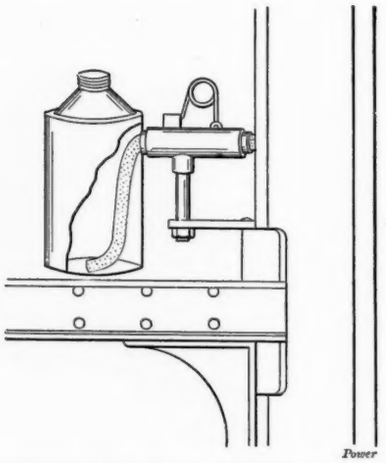
The sheet-steel box reinforces the alloy metal, and as the inner surface of the box is made with anchor cavities, the metal, when set, becomes firmly attached to the box portion, thus preventing working of the bearing metal from the box section.



BOLLINCKX PATENT BEARING

The Perfection Elevator Guide Lubricator

This lubricator, which is illustrated and described herewith, consists of a can in which light machine oil is stored. A wick passes through a holder from the can and is held against the guide rail of the elevator by means of a spring as shown. The oil is fed by capillary attraction. There is no spattering or waste of the lubricant when the car is stopped or in operation. This lubricator is made by the Perfection Lubricator Company, 3 Linden street, Cambridge, Mass.



PERFECTION ELEVATOR GUIDE LUBRICATOR

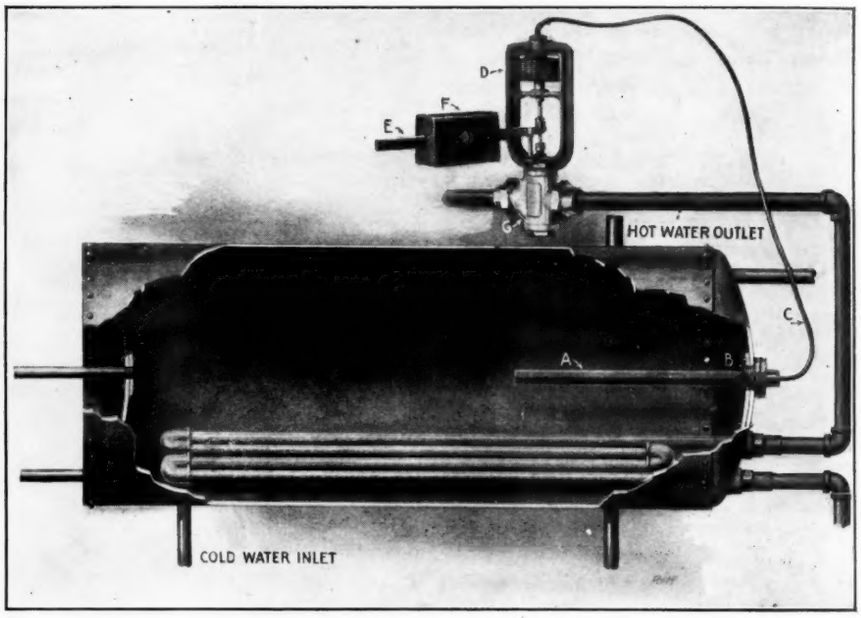
Ideal Sylphon Tank Regulator

The accompanying illustration shows a new temperature regulator for hot-water storage tanks heated by steam. The brass stem *A* screws into the storage tank through a 1¼-inch opening *B*, in either the end or the side of the storage tank. A small flexible brass tube *C* connects the stem *A* with a metal bellows *D*, which operates the valve *G* controlling the flow of steam to the heating coil in the tank. This arrangement permits the valve *G* to be installed at any desired point in the steam line.

The stem *A*, tube *C* and bellows *D* are hermetically sealed, and confine a liquid which vaporizes at low temperatures. When the water in the tank becomes heated, vapor generated in the stem *A* exerts a sufficient pressure to force some of the liquid through the pipe *C* into the bellows *D*, which expands the latter by overcoming the counterpoise weight *F* and closes the valve *G*, thereby preventing further admission of steam to the coil in the tank. When the water in the tank cools slightly, some of the vapor in the stem *A* condenses and allows liquid to flow from the bellows *D*, through the tube *C* back into the stem *A*. This permits the bellows to collapse and open the valve *G*. By moving the weight *F* backward or forward on the arm *E*, the regulator is adjusted to operate at any desired temperature between 140 and 200 degrees Fahrenheit.

Extreme sensitiveness of action is claimed, due to the great power quickly generated by the volatile liquid and to the flexibility of the metal bellows or diaphragm. The outfit is completely self-contained, requiring no auxiliary power, and is made entirely of metal.

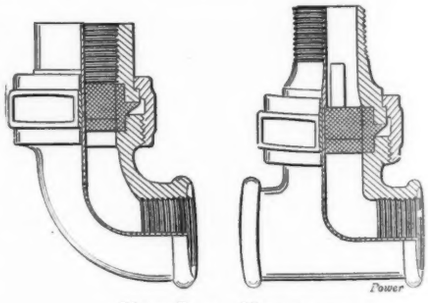
It is sold by the American Radiator Company, 282 Michigan avenue, Chicago, Ill.



SYLPHON TANK REGULATOR ADJUSTED TO A TANK

New Dart Unions

The accompanying illustrations show two of a new line of unions now being made by the E. M. Dart Manufacturing Company, Providence, R. I. These are simply an adaptation of the regular union, having two bronze seats and used in connection with the regular forms of pipe fittings. Although only an elbow and a tee are shown, these can be made in any desired combination, the bronze joint being at any opening of the fitting, and the coupling either male or female, as desired. They have the strength of iron-pipe fittings in the pipe end, are made with strong nuts, substantial shoulders and in heavy patterns.



NEW DART UNIONS

Have all defects and leaks repaired without delay. Don't wait until tomorrow.

50-Ton Crane Serves Coffee

Who ever heard of a crane being used to serve coffee? Nevertheless this is what actually happened at a banquet given on the evening of September 6 by the Nelson Valve Company, of Philadelphia, to the executive, operating and sales forces of the company. The dinner was a formal recognition of the completion of a new $1,500,000 open-hearth steel foundry. The crowning feature was the serving of the coffee, which had been arranged by Vice-president Carlisle Mason. This was done in imitation of pouring a heat. At a given signal the huge traveling crane began to move slowly on the overhead tracks until it reached the furnace. Then there was a flash and a red glow filled the room. Back swung the crane until it was just above the heads of the diners. The coffee was carried in a huge "bull ladle" suspended from the crane, and the coffee was poured directly into the cups from a spigot at the bottom of the ladle. The tables were turned on Mr. Mason, however, when the crane made a second journey and returned with a box containing a solid silver loving cup, 14 inches high, which was presented to the vice-president by the executives of the company.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

ROTARY ENGINE. John H. Zimmer, Omaha, Neb. 968,630.

GAS ENGINE. Baxter M. Aslakson, Salem, Ohio. 968,636.

ROTARY ENGINE. George H. Gross, Harrisburg Penn. 968,653.

INTERNAL COMBUSTION ENGINE. Theodor Reuter, Winterthur, Switzerland. 968,690.

INTERNAL COMBUSTION ENGINE. Georg Schimming, Berlin, Germany. 968,695.

EXPLOSION ENGINE. Martin Sears, Los Angeles, Cal. 968,702.

EXPLOSIVE ENGINE. Jay E. Woolf, Minneapolis, Minn., assignor of one-half to Ellis J. Woolf, Minneapolis, Minn. 968,725.

MOTIVE POWER SYSTEM. Alfred Wilstam, Los Angeles, Cal. 968,724.

ROTARY ENGINE. Frank Nearing, New York, N. Y. 958,786.

ELASTIC FLUID TURBINE. Raymond N. Ehrhart, Pittsburg, Penn., assignor to The Westinghouse Machine Company, a Corporation of Pennsylvania. 968,840.

ENGINE HAVING ROTARY PISTON. Friedrich Carl Kruger, Hanover, Germany. 968,859.

TIDE AND WAVE POWER. Ernesto Fuchs, Guadalajara, Mexico. 968,930.

ROTARY ENGINE. Craven Robert Ord, McAdam Junction, New Brunswick, Canada. 968,969.

ROTARY MOTOR. Herman Van Ormer, Hartford, Conn., assignor to Liberty Manufacturing Company, Pittsburg, Penn., a Corporation of Pennsylvania. 969,010.

ROTARY ENGINE. Walter Ball, Boston, Mass. 969,026.

COMPOUND ENGINE. Charles Benson, Lake City, Minn. 969,027.

ROTARY ENGINE. Roland E. List, Zanesville, Ohio. 969,070.

BOILERS, FURNACES AND GAS PRODUCERS

SMOKE CONSUMING FURNACE. Paul J. Kraetsch, Des Moines, Iowa. 968,570.

GRATE. David Boles and Joseph A. Waddell, Jr., Scranton, Penn., assignors to Spencer Heater Company, Scranton, Penn., a Corporation. 968,735.

OIL BURNER. Charles C. Wilson, Quincy, Ill. 968,825.

POWER PLANT AUXILIARIES AND APPLIANCES

TIMER FOR GAS ENGINES. Baxter M. Aslakson, Salem, Ohio. 968,635.

SPARK PLUG. Herbert F. Provandie, Boston, Mass., assignor of one-half to The Randall-Faichney Company, Boston, Mass., a Corporation of Massachusetts. 968,687.

FORCE FEED OILER. Gustave E. Franquist, New York, N. Y. 968,929.

WATER JACKET FOR EXPLOSIVE ENGINES. John F. Dodge and Horace E. Dodge, Detroit, Mich. 968,545.

CHECK VALVE. Enoch H. Heilig, Shelby, Iowa. 968,559.

CARBURETER. Joseph W. Parkin, Philadelphia, Penn. 968,597.

SPARK PLUG. Daniel M. Tuttle, Canastota, N. Y. 968,612.

TOOL FOR UPSETTING AND CALKING STAYBOLTS. George E. Wood and Edward C. Meier, Phœnixville, Penn., assignors to Heine Safety Boiler Company, St. Louis, Mo., a Corporation of Missouri. 968,625.

GUARD FOR PIPE UNIONS. Lester R. Fogg, Darby, Penn. 968,759.

STOP COCK AND DRAIN VALVE. William E. Peare, Cincinnati, Ohio. 968,794.

STEAM TRAP. William Mudd Still and Andrew George Adamson, London, England. 968,812.

SCREW PUMP. Erastus E. Bennett, New York, N. Y. 968,829.

PIPE END CLOSURE. William R. Jeavons, Cleveland, Ohio. 968,853.

CONDENSER. Ehregott T. Winkler, Kansas City, Mo., assignor of one-third to P. A. Hildebran, one-third to D. P. Gray, and one-third to John W. Roberts, Kansas City, Mo. 968,909.

VALVE CONSTRUCTION. Andrew Benner, Detroit, Mich. 968,916.

VALVE MECHANISM FOR GATE VALVES. George J. Henry, Jr., San Francisco, Cal., assignor of one-half to The Pelton Water Wheel Company, a Corporation of California. 968,944.

FEED WATER REGULATOR. Rudolph M. Hunter, Philadelphia, Penn., assignor to Charles Motley Clark, Philadelphia. 968,948.

FEED ARRANGEMENT FOR TUBE BOILERS. Louis Marie Gabriel Delaunay-Belleville, Paris, France, assignor to Societe Anonyme des Etablissements Delaunay-Belleville, St. Denis, France, a Corporation of France. 968,042.

FEED WATER REGULATOR. Timothy J. Quirk, South Boston, Mass. 969,078.

MUFFLER. Hugo C. Gibson, New York, N. Y. 969,101.

STEAM SUPERHEATER. George J. Churchward, George H. Burrows, and Clifford C. Champeney, Swindon, England. 969,088.

ELECTRICAL INVENTIONS AND APPLIANCES

ELECTRIC MOTOR METER. Arthur Zipplies, Mosbach, Germany, assignor to Aktiengesellschaft Korting's Elektricitatswerke, Berlin, Germany. 968,631.

ELECTRIC SAFETY SWITCH. Clarence D. Platt, Bridgeport, Conn. 968,796.

ELECTRIC SWITCH OPERATING MEANS. Albert Whiton Bailey, Spokane, Wash. 968,520.

AUTOMATIC SYNCHRONIZER. Paul MacGahan, Wilkinsburg, Penn., assignor to Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 968,579.

ELECTROPLATING TANK. Edwin R. Williams, Streator, Ill., assignor to The Streator Metal Stamping Company, Streator, Ill., a Corporation of South Dakota. 968,622.

ELECTRIC OVEN. Leon F. Parkhurst, and Harry G. Weeks, Binghamton, N. Y., assignors to Diamond Electric Company, Binghamton, N. Y., a Corporation of New York. 968,683.

ELECTROMAGNETIC DRILL. Frank E. Baney, Smelser, Wis., assignor of one-half to James E. Kennedy, Platteville, Wis. 968,729.

MEANS FOR ELECTRICALLY HEATING WATER-COOLED COMBUSTION ENGINES. Abbot Augustus Low, Horseshoe, and August Wassmann, Astoria, N. Y., said Wassmann assignor to said Low. 968,780.

SYSTEM AND METHOD OF ELECTRICAL DISTRIBUTION. Percy H. Thomas, Montclair, N. J., assignor to Cooper Hewitt Electric Company, New York, N. Y., a Corporation of New York. 968,896.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., W. W. Freeman, Brooklyn, N. Y.; sec., T. C. Martin, 31 West Thirty-ninth St., New York.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U .S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railroad, Cleveland, O. Next annual meeting at Chicago, Oct. 10-13, 1910.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Dugald C. Jackson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, John Cope; sec., J. U. Bunce, Hotel Statler, Buffalo, N. Y. Next annual meeting in Philadelphia, Penn., week commencing Monday, August 7, 1911.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee 606 Main St., Peoria, Ill. Next convention, Denver, Colo., September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.

Do's for Engineers

Do all that you can for your employer.

Do the best of work at all times.

Keep your eyes open in the plant and try to make improvements.

Keep the engine in good running order.

Keep the oil holes clean.

Be sure that the machinery is in good condition before starting up.

Be sure not to leave the engine room very long while the engine is running, unless there is someone around.

See that all boiler connections are in the best of order.

Keep the water-gage cocks clean and blow them frequently.

Get the best men if you are a chief and develop them into better employees.

See that all nuts are tight.

Be sure that there are oil grooves where needed in the boxes.

Keep the details well looked after.

Make a job right for all possible needs —not just good enough.

Make all changes and repairs as good as the rest of the job.

Keep everything clean around the plant and in the best of condition.

Keep from getting into the habit of saying, "I have done enough for today, and will do the rest tomorrow," as tomorrow never comes.

Keep in touch with the latest developments in the engineering line by reading a good engineering magazine.

BUSINESS ITEMS

In order to better serve its many customers throughout the South, the International Acheson Graphite Company has opened a Southern branch at Atlanta, Ga.

Wm. B. Merrill & Co., Boston, Mass., advise us that their business has grown to such an extent that they have had to enlarge their plant to take care of the increased business. They have installed a 20-horsepower Fairbanks gas engine, new lathes, new planers, so that the orders can be kept up with.

The United States Indestructible Gasket Company, Hudson Terminal building, New York, is building a new plant in Brooklyn, N. Y., which will have a space for machines equal to 10 feet wide by 500 feet long. This new plant affards greatly increased facilities for the manufacture of its products, consisting of corrugated, flat and grooved copper, lead, steel, bronze, indestructibleite, Ames alloy, Norway and Swedish iron, Monel metal, sparkite, copper-asbestos, wire, paper and other gaskets, and other specialties.

The Lagonda Manufacturing Company, Springfield, Ohio, announce that they have bought out the Enterprise Machine Manufacturing Company, acquiring the rights and patents for the full line of water strainers and tube cleaners manufactured by the latter. Special attention is being paid to the development of the water strainer. Although this strainer has been on the market for several years and is well beyond the experimental stage, the Lagonda Manufacturing Company has made several important improvements and the apparatus is now known as the Lagonda-Enterprise strainer. This strainer is suitable for removing impurities from boiler feed water, circulating water, etc.

NEW EQUIPMENT

A new electrical substation will be equipped at Ingersoll, Ont.

Robert McGinnis, of O'Neil, Neb., will erect a modern creamery.

The city of Hull, Que., will extend its waterworks system.

Edmunston, N. B., will install a new waterworks system.

Ottawa, Canada, will spend $2,000,000 extending its water system.

The Greenville (Tex.) Railway Company will construct a power house.

The Oneonta (N. Y.) Milk Company is erecting a two-story creamery.

The State Tuberculosis Sanatorium, Alto, Ga., will erect a power house.

The city of Vernon, Tex., voted bonds for the construction of waterworks.

Chippewa, Ont., will make large extensions to its waterworks pumping plant.

Prince Rupert, B. C., is in the market for equipment for its electric-light plant.

The Brookline (Mass.) Water Works contemplates the addition of another pump.

The Exchange Packing House Company, Colton, Cal., will erect a packing plant.

The town council, Fort Mill, S. C., is considering the construction of waterworks.

The city of Britton, Okla., will vote on issuing $35,000 bonds for its waterworks.

The city of Tulsa, Okla., will install another pump of 4,000,000 gallons capacity.

North Buxton, Ont., wants figures for a new pump house, wheel, boiler, engine, etc.

The Goliad (Tex.) Water and Light Company contemplate establishing a light plant.

Allen P. Wilson, New Boston, N. H., is in the market for a 15- to 20-horsepower oil engine.

The plant of the Union Ice Company, Mentone, Cal., was destroyed by fire. It will be rebuilt.

The Tulsa Corporation, Tulsa, Okla., will install a 600-kilowatt turbine and additional boilers.

Fire did about $12,000 damage at the plant of the Cadillac (Mich.) Water and Light Company.

The city council, Marion, Ind., is said to have purchased site for a municipal street-lighting plant.

The New Method Laundry Company, Los Angeles, Cal., is having plans prepared for engine-room addition.

The Arlington Hotel Company, Santa Barbara, Cal., contemplate installing an electric-light and power plant.

The Davenport (Iowa) Locomotive Works has awarded contract for the construction of a $10,000 power house.

The city of Tacoma, Wash., has passed an ordinance providing for the construction of a substation to cost $104,000.

The Evanston (Wyo.) Electric Light Company proposes to construct a power plant as soon as water rights are secured.

The city of Haskell, Okla., will open bids September 22 for waterworks. Two pumps, boiler, fire hydrants, etc., will be needed.

The Wheeling (W. Va.) Electrical Company has been granted a franchise and will at once commence work on a $700,000 plant.

Plans are being prepared for a new building for Youngs Market Company, Los Angeles, Cal. Complete refrigerating system will be installed.

The Bartlesville (Okla.) Interurban Railway Company will install another 500-horsepower battery of boilers and a direct-connected generating set.

The city of Mansfield, Ohio, contemplates making additions and changes in its waterworks. Information can be obtained of John Cahall, director of public service.

The Hillsboro (Ill.) Electric Light and Power Company has purchased site for a new plant which will be four times the size of the present central station.

J. J. Lambach, Wm. Harper, W. J. Benjamin and W. B. Bunker, all of Las Vegas, N. M., have been granted a franchise to erect a power plant. This is to cost $100,000.

Bids will be received by the trustees of public affairs, Jackson, Ohio, until September 29, for furnishing material and enlarging and improving its municipal electric-light plant.

The San Diego (Cal.) Electric Railway Company will erect a new power plant covering a whole city block in Artic, Cal. This will cost about $225,000 and will have a capacity of 35,000 kilowatts.

The Milwaukee (Wis.) Electric Railway and Light Company, recently obtained permit to build an $80,000 addition to the Commerce street power house; also a substation at Clinton and Maple streets to cost $25,000.

The San Joaquin Valley Power Company has begun the erection of a station on Union avenue, Bakersfield, Cal. The plant will contain eight boilers of 300 horsepower each, two engines and two 2500-kilowatt generators.

NEW CATALOGS

Trenton Engine Company, Trenton, N. J. Catalog. Reeves steam engines. Illustrated, 38 pages, 6x9 inches.

American Steam Packing Company, Boston, Mass. Catalog. Packings. Illustrated, 56 pages, 4½x6½ inches.

De Laval Steam Turbine Company, Trenton, N. J. Catalog. Centrifugal pumps. Illustrated, 96 pages, 6x9 inches.

B. F. Sturtevant Company, Hyde Park, Mass. Catalog No. 175. High-pressure blowers. Illustrated, 44 pages, 6x9 inches.

Ridgway Dynamo and Engine Company, Ridgway, Penn. Catalog. Four-valve engines. Illustrated, 22 pages, 8x10½ inches.

The Direct Separator Company, Syracuse, N. Y. Catalog. Sweet's combination oil and water separators. Illustrated, 12 pages, 6x9 inches.

Schutte & Koerting Company, Philadelphia, Penn. Catalog 1, Section A. Koerting universal double-tube injectors. Illustrated, 16 pages, 8x11 inches, paper.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

SALESMEN—We have an A-1 proposition for high-grade salesmen. Address Box 247, POWER.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn street, Chicago.

WANTED—Draftsman familiar with boiler-room practice, October 15. Location Northeastern Ohio. State age, qualifications and experience fully. Address Vulcan Furnace Company, Ellicott Square, Buffalo.

WANTED—Competent chief engineer for a plant in a village near Rochester, N. Y.; must be capable of making his own repairs and doing steam fitting; salary $1200 to start. Address Box 278, POWER, stating experience in detail.